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SCIENCE

15 June 1956

Volume 123, Number 3207

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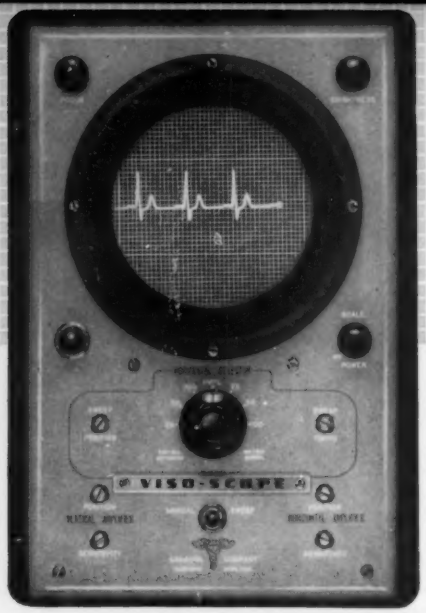

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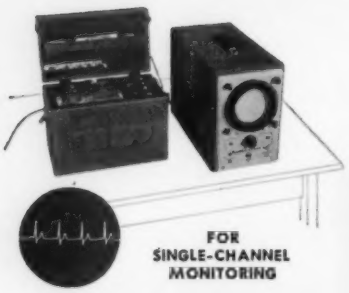

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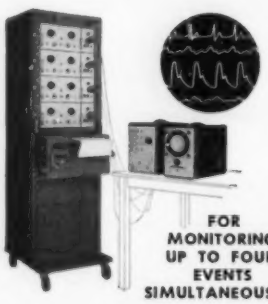

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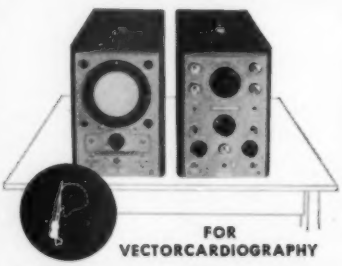

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Test by Testimonial

The recent decision of the Federal Trade Commission to drop its charges of false advertising against Pioneers, Inc., the Oakland, California, company that produces the battery additive AD-X2, has important implications for scientists and the general public.

At the request of the FTC and later of the Post Office, the National Bureau of Standards tested the additive and reported in 1952 that its composition was "essentially the same as that of a number of other additives examined during past years by the Bureau: In all cases, the results have shown that these materials are worthless."

In 1953, the Senate Small Business Committee began hearings about the additive. The chairman of the committee, Senator Edward J. Thye, asked the Post Office Department, which had issued a fraud order preventing Pioneers, Inc., from using the mails, to suspend that order. The department complied.

Secretary of Commerce Sinclair Weeks was the first to testify at the hearings and may reasonably be said to have set the keynote for subsequent sessions when, after saying that he did not want to "be accused of overruling the findings of any laboratory," he added, "But as a practical man, I think that the National Bureau of Standards has not been sufficiently objective, because they discount entirely the play of the market place." A curious view of objectivity! The Secretary said further that there were "many testimonials to the fact that the product is good and has saved the users money. As a practical man, I do not see why a product should be denied an opportunity in the market place."

In the committee report for 1954, Senator Thye's introductory remarks also help us to understand the course of the hearings. He stated that the "committee views with sympathetic attention the problems of small business men who find themselves at odds with any Government body which holds life-or-death power over them."

During the hearings, Secretary Weeks dismissed the director of the Bureau of Standards, but reinstated him in response to public outcry; he appointed one committee to consider the work of the Bureau of Standards; he asked the National Academy of Sciences to appoint another committee to appraise the work of the Bureau on the battery additive AD-X2. After consideration of conflicting and less well controlled tests, the eminent committee so appointed reported that the work of the Bureau in battery testing was excellent, and concluded that "the relevant data now available . . . are adequate to support the position of the Bureau of Standards that the material is without merit."

Nevertheless, on 16 May 1956, the FTC dismissed its false advertising charges against Pioneers, Inc. The commission upheld the hearing examiner, who on 9 November 1955 said that "The greater weight . . . [of the scientific testimony] is on the side of the complaint," but that the "overwhelming" weight of consumer testimony . . . is with the respondents and is "particularly significant and helpful in the present case, in view of the conflict in scientific evidence."

The commissioners overemphasize the conflict in scientific evidence, for the experiments done at the Bureau of Standards were the most extensive and conclusive. We also wonder whether they do not put too much reliance on the testimony of users, which has, it seems to us, doubtful validity as evidence or, in legal terms, little probative value. *Caveat emptor*!—G. DUS.

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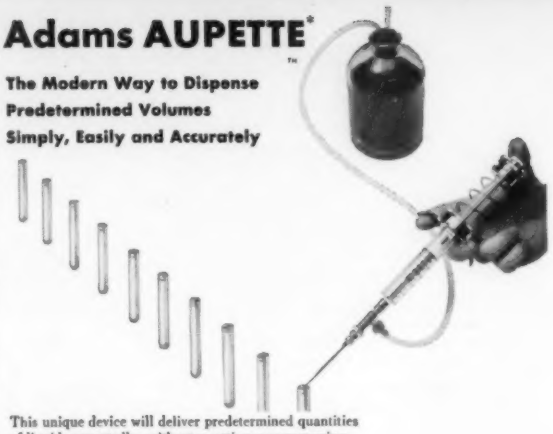

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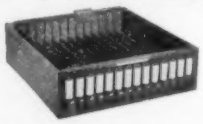

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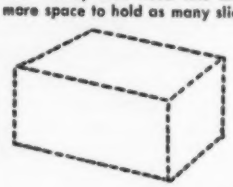

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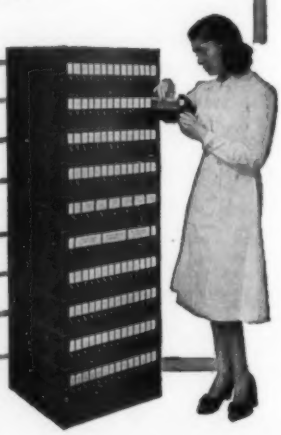

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SCIENCE

A Theory of Ice Ages

Maurice Ewing and William L. Donn

This article is a preliminary report of new ideas related to the origin of glacial climates; it is based largely on observations made during the last 20 years. Glacial climates pose two problems: (i) the striking alternations during the Pleistocene epoch of glacial and interglacial stages and (ii) the even more striking change from the warm nonglacial climate, which prevailed generally from the Permian to the Pleistocene, to the cold and glacial conditions of the Pleistocene and Recent.

If it is difficult to answer the second question, it is even more difficult to solve both problems on the basis of a single theory. The present study (*1*) offers an explanation for the alternations in climate during the Pleistocene and proposes an explanation for the change from nonglacial to glacial climates.

Pleistocene Glacial and Interglacial Stages

First we wish to develop the following principal points of the glacial-interglacial theory.

1) The melting of an Arctic ice sheet (such as exists at present) would increase the interchange of water between the Atlantic and Arctic oceans, cooling the North Atlantic and warming the Arctic and making it ice-free, thus providing an increased source of moisture for the polar atmosphere.

2) Two factors would then favor the growth of glaciers: (i) increased precipitation over arctic and subarctic lands and (ii) changes in atmospheric circulation, the latter also resulting from the warmer Arctic and cooler Atlantic oceans.

3) The lowering of sea level would greatly decrease the interchange of water between the Atlantic and Arctic oceans, which, together with the cooling effect of surrounding glaciers, would reduce Arctic surface temperatures until abrupt freezing occurred. The fairly sudden reversal of conditions favorable to glacial development would terminate the growth of glaciers abruptly.

4) As continental glaciers waned, the sea level would rise, causing an increased transport of surface waters northward until the Arctic ice sheet melted once again, completing the cycle.

5) Temperature changes in the surface waters of the Arctic and Atlantic oceans are thus the causes of, rather than the consequences of, the waxing and waning of continental glaciers.

Abrupt change in Atlantic deep-sea sediments. Using radiocarbon measurements, Ericson *et al.* (*2*) and Rubin and Suess (*3*) have established dates as far back as 30,000 years ago for cores of deep-sea sediments. Using paleotemperature measurements based on the oxygen isotope ratio, Emiliani (*4*) determined the temperature of the water in which pelagic Foraminifera lived; his findings covered a time interval represented by the longest cores available. Suess (*5*) then combined these two sets of results by plotting the radiocarbon ages for three deep-sea cores from the equatorial Atlantic and Caribbean against the paleotemperatures of Foraminifera tests. The resulting graph may be interpreted as showing a temperature decline of 1°C per 11,000 years for the interval from 90,000 to 11,000 years before the present. Temperatures then began an abrupt increase at a rate of about 1°C per 1000 years from 11,000 years ago to a few thousand years ago. For the last few thousand years, temperatures have remained about as high as the maximum value that was reached during all Pleistocene interglacial stages (see Emiliani, *4*, Figs. 2 and 3).

The curve given by Suess for Core A 172-6 shows the abrupt temperature change beginning about 16,000 years ago as compared with the change shown at 11,000 years in the other cores. Since the time scale for this core depends on only three points, considerable interpolation is required, and since Emiliani shows that a strong solution of carbonates occurred in a number of places, linear interpretation is likely to be unreliable.

In addition, faunal studies by many investigators show that a well-marked change in most cores indicates the termination of the Wisconsin age. In 1935, Schott (*6*) described the faunal break in many equatorial Atlantic cores, which was later noted in more recent longer cores—for example, by Bramlette and Bradley in 1940 (*7*), Phleger, Parker and Pierson (*8*), Ovey (*9*) and Schott (*10, 11*). Most recently, radiocarbon measurements on a number of cores described by Ericson and Wollin (*12*) from the Atlantic Ocean and Caribbean Sea show that this characteristic break (*13*), marking a change from cold to warm pelagic fauna, occurred 11,000 years ago (*2*). Cores taken in the Gulf of Mexico show a similar faunal break (*14*), although as yet no quantitative temperature or time measurements have been made. However, on the basis of the fauna change, it is possible to correlate the break in the Gulf of Mexico with that described in the Atlantic Ocean.

Cores from the Gulf of Mexico. Many sediment cores 30 to 40 feet long have been taken on the Mississippi Cone (*15*), which spreads over most of the deeper part of the Gulf of Mexico from a vertex just off the Mississippi Delta. These cores, which show a layer up to 2 feet thick of foraminiferal lutite, indicating warm water, overlie with a sharp transition a layer of essentially unfossiliferous lutite and silt, the bottom of which was never reached. Pending radiocarbon measurements, it seems reasonable to extrapolate the date of 11,000 years ago for the bottom of the foraminiferal layer. In cores taken on the nearby Sigsbee Knolls, which rise 20 fathoms above the cone and above the reach of turbidity

Dr. Ewing is director of the Lamont Geological Observatory of Columbia University. Dr. Donn is a research associate at Columbia University and assistant professor of geology and meteorology at Brooklyn College.

currents, Foraminifera of the cold-water type are abundant throughout the silty layers (*14*). It is concluded that the extreme scarcity of Foraminifera in the silty layer of the Mississippi cone is due to dilution from a great influx of clastics in Wisconsin time. The sediments give no evidence of any climatic change except that 11,000 years ago.

Further, the beginning of rapid postglacial rise in sea level is indicated by the abrupt decrease in clastic deposition on the Mississippi cone about 11,000 years ago, when the drowned rivers retained their clastic sediments instead of discharging them into the Gulf (*15*).

The result of a very recent investigation of turbidity current deposits made by Heezen and Ewing (*16*) shows that an abrupt rise in sea level must have taken place about 11,000 years ago; this event is also taken to mark the close of the Wisconsin glacial stage.

Conclusions from Atlantic and Gulf data. On the basis of these data, we regard 11,000 years ago as the date of the most recent significant temperature change in the Atlantic Ocean, and also as marking the end of the Wisconsin glacial stage. Additional breaks in isotopic temperatures (*4*) and faunal types (*7, 8, 11, 12*) occur in many of the Atlantic cores which penetrate most of the Pleistocene. We regard these as marking the transition from earlier glacial to interglacial stages.

The data show that this fairly abrupt increase in temperature in the surface layers of the Atlantic Ocean about 11,000 years ago was the most significant temperature change of the past 60,000 to 80,000 years, although similar changes occurred earlier in the Pleistocene. Because the beginning of glacial retreat which closed the last Wisconsin substage (Mankato) occurred about 11,000 years ago—for example, Flint (*17*)—it appears that the oceans became warm abruptly at the time retreat commenced and remained warm during retreat of the ice.

We propose to show that the temperature of the surface layer of the ocean, rather than external conditions, regulated the climate of the land. Specifically, we suggest that the alternating warm and cold stages of Pleistocene climate are the effects of fairly abrupt alternations between warm and cold conditions of the upper layer of the Atlantic and Arctic oceans. We are thus led to consider the cause of the pronounced fluctuations of the temperature of the Atlantic and Arctic oceans.

Arctic Ocean cores and the influence of the arctic. Three short cores (9, 14, and 16 centimeters long) and one long core (81 centimeters long) were taken in the deeper part of the Arctic Ocean by A. P. Crary and studied by D. B. Ericson. The upper 20 centimeters of the 81-centimeter core contain abundant Foraminifera (*Globigerina*), which decrease in the next underlying 10 centimeters. The long section below 30 centimeters consists of lutite, with granules and pebbles distributed sparingly throughout, and shows no *Globigerina* except for a few near the bottom. Several radiocarbon measurements on the Foraminifera of the 16-centimeter core (*18*) gave an age from 18,000 to 23,000 years. Other cores, collected elsewhere in the Arctic by Crary, show thin sediment zones above the foraminiferal layer. The presence of this upper foraminiferal zone, with no or only thin overlying sediment, indicates an abrupt end of conditions favorable to the growth of Foraminifera and suggests that the Arctic Ocean was open during the Wisconsin glacial stage. Further, the coarse fragments in the long lower section of the core are attributable to ice rafting under conditions that provided numerous icebergs free to move in open water. This condition would be met by an ice-free Arctic during Wisconsin time. The absence of *Globigerina* in the lower section of the core, except for the very bottom, can be explained by dilution by clastic sediments; and the presence of Foraminifera in the upper portion can be explained by a decrease in the amount of clastics. This is analogous to the similar, well-founded observations on cores from the Gulf of Mexico that were described in a preceding paragraph.

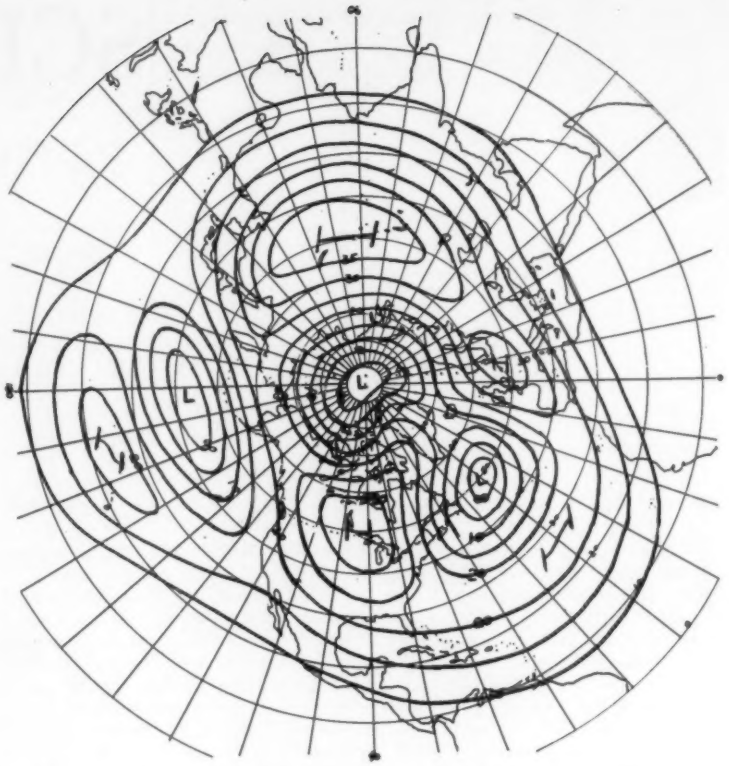

Fig. 1. Chase's map of hypothetical pressure pattern during a glacial age with an ice-free Arctic Ocean. Air motion is clockwise about high-pressure areas (*H*) and counterclockwise about low-pressure areas (*L*). Continental highs correspond to present-day cold winter situations.

Based on the possibility that the Arctic Ocean can undergo both ice-free and ice-covered stages, we propose the following assumption: When the Arctic Ocean is ice-covered, surface temperatures in the Atlantic increase and continental glaciers decline; when the Arctic is open, surface temperatures in the Atlantic decrease, and continental glaciers develop. With this assumption in mind, let us examine the process by which an ice-free Arctic can bring about a glacial stage.

Consequences of an ice-free Arctic Ocean. Given an open Arctic Ocean, the resulting large increase in absorption of insolation is well known. The present circulation of water within the Arctic Ocean would be greatly increased (*19*)

since the wind stresses would then be applied directly to the water. It is postulated that a marked increase in the interchange of water between the Arctic and Atlantic oceans would occur which would tend toward equalization of temperatures, cooling the Atlantic and warming the Arctic. With the added effect of greater absorption of insolation, the ice-free condition of the Arctic Ocean could be maintained against the cooling effect of increased evaporation.

The present mean temperature of the surface of the Arctic Ocean in January is – 35°C and in July, about 0°C. The vapor pressure of water (or ice) at 0°C is 4.6 millimeters of mercury; at 3°C, 5.7 millimeters; and for ice at – 30°C, 0.3 millimeter. The change to an ice-free condition would necessarily require an increase of winter ocean surface temperatures by at least 35°C. By extrapolating from the afore-mentioned data, it can be seen that the vapor pressure would increase by a factor of about 50 in the winter season, while the summer ocean surface temperature and vapor pressure would be only a little increased. The principal effect of an open Arctic is thus the providing of greater moisture during the long polar winter.

Although it is difficult to make a detailed analysis of the consequent changes in atmospheric and oceanic circulations and the results thereof, the following general conclusions seem reasonable.

1) The increased evaporation from an open Arctic Ocean, particularly in winter, would increase the precipitation over adjacent cold land areas, where lack of precipitation, rather than high temperatures, at present prevents the growth of glaciers (for example, Stokes, *20*).

2) The present polar high, with clockwise circulation, would be replaced by a low-pressure area with counterclockwise circulation because of the contrast between the warm water and the surrounding colder land. The resulting reinforced counterclockwise circulation of the Arctic Ocean would tend to increase further the interchange of Atlantic and Arctic waters, judging from the present North Atlantic circulation.

3) The semipermanent North Atlantic low would be displaced roughly 10 to 20 degrees southward. Increased zonal flow of air around the northern portions of this low would transport cool moist air over eastern North America. At the same time, the presence of relatively warm water on all sides of the continents would promote the development of cool continental highs.

4) Winter and summer conditions over the continents would become more similar as a permanent continental ice sheet developed, with a resulting migration of the present polar front southward.

5) The contrast between the cold northern land areas and the warmer open Arctic Ocean would result in a second, although weaker, polar frontal zone surrounding the polar low.

6) A second belt of storms would therefore be present, providing some nourishment for growing glaciers at the northern margin, in addition to the stronger nourishment at the southern margin.

7) The Atlantic Ocean would be cooled by lowered air temperatures induced by continental glaciers and by the abrupt cooling effect of increased interchange with the Arctic Ocean already mentioned.

J. Chase has given a general confirmation of these views in an analysis (see Fig. 1) that followed a presentation of the ideas of this paper at a colloquium at the Woods Hole Oceanographic Institution (*21*). His analysis is based on a study of extreme conditions shown on historical weather maps and represents hypothetical mean isobars during a glacial stage having an open Arctic Ocean.

Termination of a glacial stage. The glacial stage would be brought to an abrupt close by the development of a new Arctic Ocean ice sheet. Along most of an Atlantic Ocean profile, through either Iceland or Spitzbergen, the sill depth between the Arctic and Atlantic oceans is between 200 and 300 fathoms, and much of this is less than 50 fathoms, a depth generally accepted as the probable value for maximum Wisconsin decrease in sea level (see Fig. 2). When the lowering of sea level reached about 50 fathoms, a serious reduction in the interchange of water between these oceans would occur. The reduced inflow of warm Atlantic water, together with the cooling effect of the continental glaciers, would eventually allow a new Arctic Ocean ice sheet to form. The interchange of water would then be reduced to even less than its present-day value, owing to the reduced sea level. Thus, with the present radiation balance and the slow return to the current atmospheric circulation pattern, there would be no tendency to remove the Arctic Ocean ice sheet until sea level returned to at least its present position. A reversal of the phenomena described as consequences of an ice-free Arctic Ocean would consequently occur. Although gradual wastage of the continental glaciers would follow, the warming of the Atlantic surface water would be more rapid because of an abruptly diminished interchange with the Arctic.

If we consider the last glacial stage, we find that the studies of deep-sea cores indicate that 11,000 years ago is the date of the end of Wisconsin time. Furthermore, the end of Wisconsin glacial conditions in the ocean corresponds with, and according to our theory, caused the end of the Mankato substage on the con-

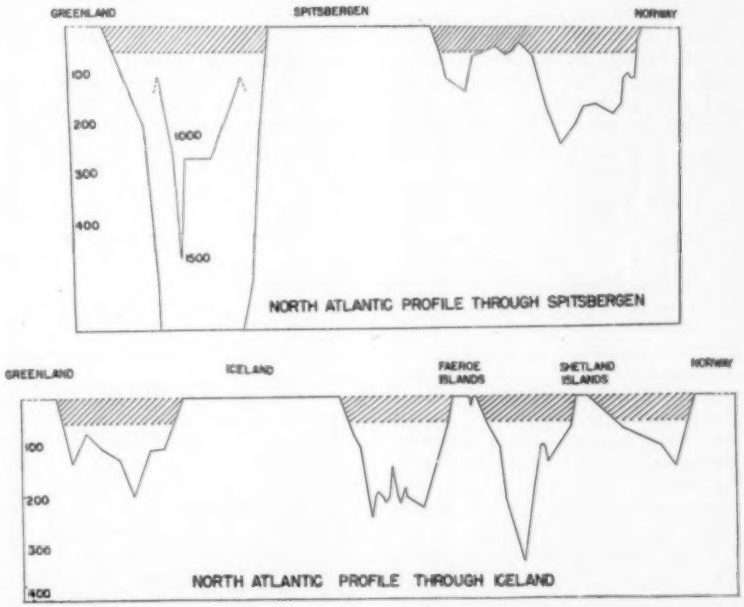

Fig. 2. Two profiles across the North Atlantic Ocean indicating the restriction of Arctic-Atlantic interchange that would result from a lowering of sea level by about 50 fathoms (hatched area) across either section. Although a narrow deep zone exists west of Spitzbergen, this is known to be a region of return flow from the north. Depths are in fathoms.

tinents. The glacial retreat between the Tazewell and Mankato glacial substage maxima (for example, Flint, *17*) is only a minor fluctuation.

The interglacial stage. The transition from glacial to interglacial conditions in the Atlantic Ocean would be simultaneous with the time of maximum continental glaciation (neglecting minor fluctuations). As the continental glaciers wasted, their cooling effects would diminish. The consequent rise in sea level would slowly enlarge the cross section of the channel between the Atlantic and Arctic oceans, providing an increase in the northward transport of warm water, as is occurring at present. Eventually a condition would be reached where the Arctic ice sheet would disappear.

Considerable evidence has been given by Berezkin (*19*) and by Crary, Kulp, and Marshall (*22*) which indicates that the Arctic Ocean has been warming recently. If that trend continues, open water over the entire Arctic Ocean might occur within a few centuries, with consequent glaciation in northern latitudes.

The presence of five temperature maxima, marking past interglacial stages, all at about the same temperature as the present (*4*) is strong evidence that an internal, self-regulating mechanism controlled the climate during the Pleistocene. Emiliani's graph of temperature versus time (*4*, Fig. 3) gives compelling evidence of oscillations of the system between two quasi-stable states, with the significant external conditions remaining constant throughout. This implies that present temperature is at the maximum value expected for an interglacial stage and that a decrease in temperature marking the onset of the next glacial stage may be expected within some few thousands of years.

In describing Pacific cores, Emiliani notes (*4*, p. 561) far less conspicuous temperature variations than in cores from the Atlantic. He explains this on the basis of greater vertical circulation in the Pacific, which seems to be a rather ad hoc solution. The observed uniformity in Pacific temperatures, however, is an expected consequence of the theory proposed here, in which strong temperature changes should be limited to the Atlantic and Arctic oceans. These observations also imply that some mechanism, involving only the Atlantic and Arctic oceans, is the most reasonable solution for the Pleistocene climatic variations.

Interpretation of Wisconsin glaciers. Our theory provides a new explanation for the Scandinavian and Siberian ice sheets. According to Flint (*23*), this sheet had a maximum thickness of about 10,000 feet, tapering off strongly to the north and east, and less strongly to the south. The combined lateral extent was from about 5°W at the British Isles to about 110°E at the Taimyr Peninsula. In view of the long continental path and the prominent mountain barriers to the south and west, it seems difficult to imagine nourishment from storms arriving from these directions. However, nourishment from the north would be provided by an ice-free Arctic Ocean, but would be almost impossible with the ice-covered ocean usually assumed for the glacial age. The steep north slope of this ice sheet further supports the theory that the source of precipitation was to the north.

The Laurentide ice sheet, which covered nearly 5 million square miles at the Wisconsin maximum (*23*), extended westward to meet the Cordilleran glaciers, and eastward to a line seaward of the present Atlantic coast, with its southern boundary along the Missouri and Ohio rivers. The maximum thickness has been estimated by Flint (*23*) to be about 10,000 feet. Although the northern boundary is not well known, it has been assumed to be thin, but recent observations by G. Hattersly-Smith (*24*) give evidence of very severe glaciation on Ward Island and northern Ellesmere Land at about 83°N. Here again, as with the northern and western margins, it is difficult to explain the sources of nourishment on the basis of present-day circulation and an ice-covered Arctic Ocean. However, the modified circulation described here provides for sources of precipitation from the Atlantic and the Arctic oceans, in addition to that coming from the south.

Finally, it is well known that the areas of the northern hemisphere covered by Pleistocene glaciers are centered roughly at the northeastern coast of Greenland, near the strait through which Atlantic and Arctic waters interchange (see, for example, Flint, *20*, plate 3). For the most part, glaciation in other areas was minor and was controlled directly by mountains. The distribution of Pleistocene glaciers again indicates the strong influence of both the Arctic and North Atlantic oceans on Pleistocene continental glaciers.

Climatic optimum. Evidence for open water in the Arctic Ocean in post-Wisconsin time has been accepted by many writers (for example, Brooks, *25*) and attributed to the "climatic optimum" or "thermal maximum" which many climatologists believe prevailed during the long interval from about 7000 to 2500 years before the present. The evidence is found in part on islands and remote shores where correlation with established chronology is difficult. We suggest that this evidence for an ice-free Arctic pertains to the open Arctic we have postulated for Wisconsin time rather than to the climatic optimum.

Other evidence for a climatic optimum is found further south on the continents, where it is correlated reliably with post-Wisconsin chronology. Although the climatic optimum is correctly dated here, we believe that it is a minor climatic fluctuation because it left no conspicuous evidence in marine sediments (*4*, *12*). Also, according to Fisk (*26*), there is no evidence of higher sea level than the present in the Gulf of Mexico during all of post-Pleistocene time.

Early man in the Americas. The facts about early man in the Americas support the idea of an ice-free Arctic during Wisconsin time and hence during earlier glacial stages. According to recent prevailing opinion—for example, Eiseley, (*27*)—early man reached Alaska from Siberia in great numbers during late Wisconsin time. The usefulness of the accepted land bridge between Siberia and Alaska would have been very limited if the Arctic Ocean had been ice-covered and the climate far colder than at present. The Denbigh Flint complex (northwestern Alaska) has been estimated from geologic correlations to correspond to warm periods either earlier than 12,000 years ago or about 8500 years ago (*28*, *29*). Based on direct observations of the Denbigh flint work, Giddings (*29*) concludes: "The Bering Strait region was already a culture center at the time of deposit of the Denbigh flint layer." Giddings further notes "that most of the early flint techniques were distributed primarily on a broad band centering at the Arctic Circle; they seldom strayed south."

We believe that these observations refer to the time of the relatively warm and open Arctic Ocean prior to 11,000 years ago. The implication of a long-established culture in the arctic region conflicts strongly with the conventional concept of a Wisconsin ice sheet continuous from the North Pole to the Ohio River. If the Arctic Ocean were open in Wisconsin time, we should expect evidence of settlements along most of the shores of the Arctic, contemporaneous with those in Alaska. Giddings (*29*) has already pointed out a similarity between cultures for the Denbigh complex and settlements in northern Siberia.

About 11,000 years ago, the break-up of the ice permitted such rapid migration of Arctic population southward that the southern tip of South America was reached in a few thousand years (*27*, *30*). The initial avenue from Alaska was the high plains east of the Rocky Mountains (*27*, *31*), which would have no mountain barrier if it commenced in the low unglaciated area north of the Brooks Range and fronting on the Arctic

Ocean. Following glacial retreat at the close of the Wisconsin stage, the route along the high plain east of the Rockies would have opened, while that from northern Siberia would have closed as sea level rose and ice formed in the Arctic Ocean. Thus, as early man migrated southward, continued migration from northern Siberia was cut off.

Initiation of Pleistocene Glacial Climate

Although the theory we have presented attempts to provide an explanation for the alternations of climate during the Pleistocene epoch, it cannot give an explanation for the initiation of cold Pleistocene climate. A solution to this problem is offered now.

Reconsideration of the hypothesis of pole-wandering. Following the recognition of the extent and distribution of Pleistocene glaciers, many scientists sought an explanation of glacial climates in terms of major shifts in the positions of the poles. Much of the early work was summarized in 1883 by Hann (*32*), who believed that great secular changes in climate could only be accomplished by changes in the earth's axis of rotation. Kelvin and other physicists demonstrated that significant pole shifts would be impossible in view of the accepted evidence for high rigidity of the earth, thereby directing most subsequent studies toward alternative explanations. However, although they used different bases for their hypotheses, Köppen and Wegener (*33*, *34*) and Milankovitch (*35*) never abandoned this idea.

In recent years attention has again been directed toward this hypothesis as it became clear that the earth could not be considered as a completely rigid body. Thus, Vening Meinesz (*36*) concluded that, "The forces causing tectonic orogeny which are probably exerted by sub-crustal currents must have been amply sufficient for a shift of the poles," and he assumed a pole shift of many degrees as the basis of his explanation of the major fracture pattern of the earth's crust. Runcorn (*37*) indicated that the earth's surface could undergo large displacements relative to the interior as a result of convection currents. In considering the direction of magnetic fields indicated by studies of paleomagnetism, Runcorn (*38*) believes that the variation in these fields could be fully explained by pole wandering.

Using a different approach, Jardetzky (*39*) recently reevaluated the work of Milankovich, concluding ". . . there was possible a slow secular displacement of the crust in space, which was progressive during all geologic periods. The cause of the rotation of the crust is the existence of a moment of centrifugal forces acting on the crust and due to the asymmetry of the distribution of masses in the outer shell."

The possibility that adequate forces exist to produce relative movement between the earth's surface and the interior has led us to reopen the question of the effects of pole wandering on secular changes in climate. It should be noted that the poles wander, according to present conception, in a relative sense. The differential movement between an outer shell and the interior results in different points on the surface assuming the positions of the poles.

Climatic consequences of pole migration. The poles are presently located in positions of extreme thermal isolation, in marked contrast to the conditions that would prevail if both were in the open ocean. If the North Pole were located in the North Pacific (for example, 35°N and 180°W) and the South Pole at the antipodes of this, in the South Atlantic Ocean, the free interchange of water with the polar regions would preclude formation of polar ice caps. The free interchange would further tend to equalize temperature extremes both geographically and seasonally. A resulting weak and uniform latitudinal temperature gradient would occur, in contrast to the present zonality. This kind of climate must have prevailed between the Permian and Pleistocene glaciations (and probably during the long intervals between other glacial periods), according to inferences made from the geologic record by all authorities.

Based on different investigations, Kreichgauer (*40*), Köppen and Wegener (*33*), Milankovich (*35*), Köppen (*34*) and Creer *et al.* (*41*), have all placed the North Pole in the North Pacific Ocean for a long interval beginning with the Cambrian. Although Milankovitch gave no dating, the other investigators estimated that the pole arrived in the Arctic Ocean during the Tertiary. On the basis of the worldwide distribution of corals of various ages, T. H. Y. Ma (*42*) concluded that sudden displacements of the solid earth shell with respect to the interior occurred. He also located pre-Cretaceous pole positions at distances of more than 90 degrees from their present positions in order to reconcile the fossil record with the appropriate climate, and concluded that abrupt shifts of the earth's crust during the Tertiary then carried the poles to their present locations. From studies of rock magnetization, Hospers (*43*) concluded that pole migration since Eocene time could have amounted to 10 degrees. It is proposed here that the migration of the poles from an open-ocean environment to the thermally isolated arctic and antarctic regions resulted in the change from the warm equable climate to the glacial climates of the Pleistocene.

Assuming that the North Pole migrated into the Arctic Ocean, the cooling effects of high latitudes would have become concentrated in this region owing to the isolation of the Arctic from the other oceans. In the same way, the migration of the South Pole from the freely circulating southern oceans to the Antarctic continent would have concentrated cooling effects over the land. Both polar regions became sources of cold "polar" air that contrasted strongly with the warm air from equatorial regions. The Pleistocene and Recent climates, characterized by marked zonality, were thus established. Growth of glaciers requiring for the most part only ample precipitation on cold continental regions (for example, Haurwitz, *44*) was greatly favored by this climate. The Pleistocene type of climate may thus be expected to continue as long as the poles remain near their present thermally isolated positions.

The motion of the poles was probably somewhat intermittent. If we consider convection to be the mechanism producing this motion, orogenies would be good indicators of convectional activity. The beginning of rapid polar motion would coincide with the major orogenies at the end of the Tertiary, and possibly also at the end of the Cretaceous. The climatic oscillations within the Pleistocene were far too rapid to be related to movements of the pole in and out of the Arctic region.

As a consequence of the theories proposed, the principal alternations between glacial and nonglacial stages would occur in the arctic. Relatively minor changes would be expected in the antarctic, resulting primarily from the slight warming and cooling of the Atlantic Ocean. Despite these minor changes, such as the present decrease in antarctic ice, the theory requires a secular increase from zero thickness at the beginning of the Pleistocene glacial epoch. There is some evidence that this has occurred. In many parts of the world, phases of high sea level are recorded by elevated beaches. Although there is some disagreement about correlations, many authors—for example, Zeuner (*43*)—identify five or six such beaches, at elevations up to about 100 meters. Zeuner showed that a graph of beach elevation against time is approximately linear. He recognized that "it seems probable that this straight line represents a more or less continuous drop of sea level in the course of the Pleistocene on which the oscillations due to glacial eustasy were superimposed." It is now suggested that this apparently

secular decrease in sea level, with attendant preservation of the beaches showing successive decreasing sea level maxima, can be accounted for by the secular growth of an antarctic ice cap. Numerous estimates that the total decrease in sea level due to present ice caps is about 60 meters have been made; an additional decrease of about 50 meters can be attributed to thermal contraction of the sea water, if the present mean ocean temperature is taken as about 10°C below the Tertiary mean. We can thus provide for a secular decrease in sea level of about 100 meters, which seems to account for the highest of the elevated beaches.

Conclusions

The theories of the origin of the Pleistocene glacial climate and of the glacial and interglacial stages proposed here are in complete harmony with the doctrine of uniformitarianism. No external influences or catastrophic events are required to initiate or maintain these conditions. It is postulated that some mechanical process has caused the poles to migrate to positions very favorable for the development of glacial climates. The major changes within the Pleistocene are considered here to have resulted primarily from the alternations of ice-covered and ice-free states of the surface of the Arctic Ocean.

For the most part, this article pertains to the Pleistocene glacial epoch and the warm interval between the Permian and the Pleistocene. Although little is known about possible glacial and interglacial stages during the Permian and Proterozoic glacial intervals, the initiation of such intervals could have been a consequence of the same mechanism as that proposed here for the initiation of the Pleistocene. The "warm" periods prevailing during the long intervals between the times of glaciations before, as well as after, the Permian could also be explained, according to the theory proposed, as a consequence of the location of the poles in regions of freely circulating oceans.

The consequences of the ideas presented are that the Pleistocene climate will continue while the poles maintain their present locations and that the Recent epoch can be considered as another interglacial stage.

References and Notes

1. This research was sponsored in part by the Research Corporation and the Engineering Foundation. This article is Lamont Geological Observatory contribution No. 187.
2. D. Ericson *et al.*, in preparation.
3. M. Rubin and H. E. Suess, *Science* **121**, 481 (1955); **123**, 442 (1956).
4. C. Emiliani, *J. Geol.* **63**, 538 (1955).
5. H. E. Suess, *Science* **123**, 355 (1956).
6. W. Schott, *Wiss. Ergeb. deut. atlantischen Expedition* Meteor **3**, 3 (1935).
7. N. M. Bramlette and W. H. Bradley, *U.S. Geol. Survey Profess. Paper 196* (1940).
8. F. Phleger, F. Parker, J. Pierson, "North Atlantic Foraminifera," *Rept. Swedish Deep-Sea Expedition 1947–48.*
9. C. D. Ovey, *Roy. Meteorol. Soc. Centennial Proc.* (1950).
10. W. Schott, *Göteborgs Kgl. Vetenskaps.- Vitterhets-Samhäll Handl. Sjätte Földgen Ser. B* **6** (1952).
11. ———, *Heidelberger Beitr. Mineral. Petrog.* **4** (1954).
12. D. Ericson and G. Wollin, *Deep-Sea Research* **3**, 2 (1956).
13. In many of the deep-sea basin areas, continuity in deposition is destroyed by the erosional or depositional action of turbidity currents; hence the chronology of the past cannot be determined with precision. However, when it became possible to take, or select for study, cores undisturbed by such action [D. B. Ericson *et al.*, *Geol. Soc. Amer. Spec. Paper No. 62* (1955), pp. 205–220], the pattern of deposition where a layer with warm-water fauna overlies a layer with cold-water fauna was unmistakable. A second complicating factor is introduced by animals, whose filled burrows frequently disturb sediment contacts. Allowance must be made for this effect in estimating the rate of change of sediment type.
14. M. Ewing and D. Ericson, "Studies of cores from the Gulf of Mexico," *Progr. Rept. Lamont Geol. Observatory* (1955).
15. ———, *Topography and Sediments in the Gulf of Mexico* (American Assoc. Petroleum Geol., in press).
16. B. Heezen and M. Ewing, *Bull. Am. Assoc. Petroleum Geol.*, in press.
17. R. F. Flint, *Am. J. Sci.* **253**, 5 (1955).
18. W. Broecker and J. L. Kulp, unpublished.
19. V. A. Berezkin, *Morskoi sbornik* **4**, 105 (1937).
20. W. L. Stokes, *Science* **122**, 815 (1955).
21. We are grateful to J. Chase for this general confirmation, which was sent in a personal communication on 28 June 1955.
22. A. P. Crary, J. L. Kulp, E. W. Marshall, *Science* **122**, 1171 (1955).
23. R. F. Flint, *Glacial Geology and the Pleistocene Epoch* (Wiley, New York, 1947).
24. G. Hattersly-Smith, *Arctic* **8**, 1 (1955).
25. C. E. P. Brooks, *Climate through the Ages* (McGraw-Hill, New York, 1949).
26. H. N. Fisk, personal communication.
27. L. C. Eiseley, *Anthropol. Soc. Washington* 75 (1955).
28. D. Hopkins and J. Giddings, Jr., *Smithsonian Institution Misc. Collections* **121**, 11 (1953).
29. J. Giddings, Jr., *Sci. American* **190**, 6 (1954).
30. W. R. Hurt, Jr., *Am. Antiquity* **18**, 3 (1955).
31. E. Antevs, "The Quaternary of North America," in *Regionale Geologie der Erde* (Akademische Verlagsgesellschaft, Leipzig, 1941).
32. J. Hann, *Handbuch der Klimatologie* (1883).
33. W. Köppen and A. Wegener, *Die Klimat der geologischen Vorzeit* (Berlin, 1924).
34. W. Köppen, *Meteorol. Z.* 106–110 (1940).
35. M. Milankovitch, *Handbuch der Geophysik* (Gebr. Borntträger, Berlin, 1938), vol. 9, pp. 593–698.
36. F. A. Vening Meinesz, *Trans. Am. Geophys. Union* **28**, 1 (1947).
37. S. K. Runcorn, *Advances in Physics* **4**, 4 (1955).
38. ———, *Endeavour* **14**, 55 (1955).
39. W. S. Jardetzky, *Trans. Am. Geophys. Union* **30**, 6 (1949).
40. D. Kreichgauer, *Die Aquatorfrage in der Geologie* (Steyl, Kaldenkirchen, 1902).
41. K. M. Creer, E. Irving, S. K. Runcorn, *J. Geomagn. Geoelect. Kyoto*, in press.
42. T. Y. H. Ma, *Bull. Geol. Soc. China* **20**, 343 (1940); *Research on the Past Climate and Continental Drift* (Privately published, Taiwan, 1952).
43. J. Hospers, *J. Geol.* **63**, 1 (1953).
44. B. Haurwitz and J. Austin, *Climatology* (McGraw-Hill, New York, 1949).
45. F. Zeuner, *Dating the Past* (Methuen, London, 1950).

Each science confines itself to a fragment of the evidence and weaves its theories in terms of notions suggested by that fragment. Such a procedure is necessary by reason of the limitations of human ability. But its danger should always be kept in mind. For example, the increasing departmentalization of universities during the last hundred years, however necessary for administrative purposes, tends to trivialize the mentality of the teaching profession.
—ALFRED NORTH WHITEHEAD, *Nature and Life* (University of Chicago Press, 1934).

News of Science

Science and International Relations

The *Saturday Review* reported in its issue of 29 May that the National Academy of Sciences is prodding the present administration to give science a direct and active role in the formulation of U.S. foreign policy. An article by John Lear states that at the recent NAS annual meeting a resolution was adopted supporting the academy president, Detlev Bronk, in his efforts to encourage the appointment of distinguished scientists by the Department of State as "Ambassadors of Knowledge."

During the previous administration, a special science adviser to the Undersecretary of State was designated, and his office was given jurisdiction over ten science attaches who were stationed in five of the capitals of Europe. A program drafted by an academy committee at that time called for eventual expansion of the science attache network to include regional representatives in London, Johannesburg, Rio de Janeiro, Sidney, and perhaps New Delhi and Cairo; other representatives were to be assigned on an individual country basis in Paris, Rome, Berne, Stockholm, Ottawa, Lima, Oslo, the Hague, and Brussels.

The article points out that now "all the Science Attaches have come home, none has been replaced, and the office of Science Advisor is occupied by an economist." Lear then invited readers to "consider the situation in our foreign relations in its full absurdity," and goes on to say:

"Soviet Russia is assigning scientific attaches to its embassies for the first time in its history. In its school at home it is training thousands of its youth in the scientific disciplines with the obvious intent of covering the globe with missionaries of technical know-how in the next generation.

"Britain, Canada, Australia, and India have science attaches in their embassies in Washington, backstopped by another science staff working jointly for the Commonwealth. Sweden stations an official scientist in this country. So do Norway, France, Germany, Austria and Japan. Little nations like Belgium, Holland, Denmark and Israel keep scientific specialists in our capital. Even the so-called backward lands—Egypt, South Africa, Yugoslavia—have scientific observers here. The United States . . . has no science attache anywhere."

In an editor's note, the *Saturday Review* asks:

"If the U.S. Navy can (as it does) keep a science staff of its own in London, and if the Atomic Energy Commission can (as it is beginning to do) plant its agents in U.S. embassies under disguised titles, why cannot the Department of State appoint Science Attaches concerned with the day-to-day effects of new discovery on our power for peace in the world?"

Glacier Campsite

Five scientists are returning this month to their campsite of last summer on a 1300-foot-thick glacier in Greenland, where they spent 2 months gathering geological data and measuring the flow of active glaciers and the formation of crevasses. The project is sponsored by the U.S. Army Corps of Engineers as part of a study of the polar regions. This year's party will be led by Thomas M. Griffis of the University of Denver.

According to conservative estimates, the massive ice fields are moving about a foot a day; the result is intense crevassing of the glaciers. These cracks in the ice are as deep as 150 feet and range from a few inches to 100 feet in width. They sometimes extend for miles across the ice sheet.

Exactly how the cracks form and grow is not fully understood. Last year, using mountain gear, the expedition members descended into a number of crevasses and planted instruments to record temperature changes and ice movements. This summer they hope to recover these instruments for reading.

The expeditions will be on the ice from about 16 June to 5 Sept. The group flew to Thule Air Force Base in Northern Greenland on 13 June, then traveled overland 20 miles to Camp Tuto, a temporary base camp maintained by the 1st Engineers Arctic Task Force. From Camp Tuto snow weasels will carry the expedition about 13 miles out onto the ice cap.

U.S. Visitors and Soviet Science

The 14 Americans who have been attending a conference in Moscow on the physics of high-energy particles issued a statement that said:

"A source of particular gratification to us has been the observation of a strong interest in pure science on the part of so many Soviet physicists. This has been reflected in our many discussions concerning basic ideas." [We are] "greatly impressed by the broad scope of the Soviet effort . . . and by the high level of both experimental and theoretical physics in the Soviet Union."

A spokesman for the group, Robert R. Wilson of Cornell University, told a news conference that the Soviets "are not just making practical things like missiles and atomic bombs, but have a big program of research." Robert E. Marshak of the University of Rochester commented that it was impossible to say whether the Soviets had swung away from research into the military applications of atomic energy to other fields, since the programs were not mutually exclusive.

Discussing their meetings with the Soviet physicists, Marshak and Wilson said the exchanges showed "no reflection of political ideas." They said: "We speak the same language. Their science shows no influence of Marxist ideology."

They also pointed out that the Soviet Government attracts the country's best minds to the natural science field through the prestige and rewards it offers. "Their scientists are relatively better off than ours," Marshak said.

Gibberellic Acid

Gibberellic acid may sound like gibberish, but it turns out to be an extremely important plant growth substance which before long may take its place beside auxin. Last year P. W. Brian and H. G. Hemming showed that gibberellic acid, which markedly stimulates the elongation of stems and leaves in a number of higher plants, acts more strikingly on slow-growing or dwarf forms of peas, broad beans, and French beans than on normal varieties (*Physiologia Plantarum* Sept. 1955). Recently B. O. Phinney of the University of California at Los Angeles found that when six genetically dwarf strains of maize were supplied with gibberellic acid, four of them responded by making normal growth as long as the compound was supplied, while two mutants remained dwarf, one of them showing only a very slight response. (*Proceedings of the National Academy U.S.A.*, April 1956).

It appears that gibberellic acid might be a normal growth-promoting substance, and that its production may be inter-

fered with by several independent gene mutations at different loci. Other mutations may, however, mimic the effect of a lack of gibberellic acid. This might be because the response of stem and leaf cells to gibberellic acid is in some way lessened, or it might be because there are other essential growth-promoting substances necessary for cell elongation. Gibberellic acid is a tetracyclic dihydroxylactonic acid, $C_{19}H_{22}O_6$.—B.G.

Amazon Fossil Search

Members of the paleontological expedition to the Juruá River, one of the major tributaries of the Amazon, left New York recently on a journey that will take them more than 2000 miles into the interior of Brazil. George Gaylord Simpson, chairman of the department of geology and paleontology at the American Museum of Natural History, is coleader of the expedition. The group has joined a party of Brazilian scientists from the National Department of Mineral Production and the Goeldi Museum that is led by Llewellyn Ivor Price. The expedition is traveling up the Juruá to the Peruvian border in search of fossil remains of early animal life.

Before his departure Simpson commented that "Although no previous paleontological study of the Juruá region has ever been attempted, small scraps of fossils brought out by traders and explorers indicate that the area may be rich in fossil deposits. Since almost nothing is now known about the evolution of the fauna of the region, any material we find should be of considerable scientific importance."

Atomic Power Plants

The British Atomic Energy Authority has announced that the first of two atomic piles at the Calder Hall atomic power station in Cumberland has begun to work. Construction of the experimental station began 3 years ago. Queen Elizabeth is to open the station officially 17 Oct.

The Authority's statement said: "For the first time in the history of the world electricity on a large scale will then be supplied from a nuclear power station to a national electricity network." In a few weeks the first electricity will be generated, but the plant will not be on full power until later. Its projected capacity is 50,000 to 70,000 kilowatts.

The only United States counterpart to the British installation at Calder Hall is the plant of approximately 60,000 kilowatts capacity that is being constructed at Shippingport, Pa. According to present plans it will be completed in late 1957. Power from Shippingport will be distributed by the Duquesne Light Company of Pittsburgh, which is contributing substantially to construction costs of the plant.

The Soviet Union plans to install five new atomic power stations in Moscow, Leningrad, and the Urals. The size of these power plants will range from 400,000 kilowatts to 600,000 kilowatts each. They are expected to be in operation by the end of the current 5-year plan in 1960. Several pilot atomic installations, each with a capacity of 50,000 kilowatts, will be operating by 1959 or 1960. A 200,000-kilowatt pilot plant also is being planned in addition to the big commercial installations.

News Briefs

■ President Eisenhower recently began a series of meetings with an advisory committee to consider the possibilities of creating some type of decoration, comparable to the Order of the British Empire and the French Legion of Honor, for citizens who distinguish themselves in the arts, letters and sciences. The President is discussing his plan with a committee consisting of Harold W. Dodds of Princeton University, Leonard Carmichael of the Smithsonian Institution, Percival Brundage, budget director, Sherman Adams, and Howard Pyle.

■ The U.S. Air Force plans to build a large solar furnace at approximately the 9000-foot level in the Sacramento Mountains near the Holloman Air Development Center, Alamogordo, N.M. This furnace, a system of mirrors that will bring the sun's rays to a focus, will be used for high-temperature research and for testing of materials and components of weapons. France has a comparable solar furnace, probably the largest there is, that is located on Mount Louis in the Pyrenees.

■ Wilhelm Reich, who developed the "orgone energy accumulator," and his colleague Michael Silvert, have been held in contempt of court and sentenced to prison. Having filed an appeal, the two men were released on $15,000 bail each.

The contempt charges grew from their failure to comply with a Federal injunction that prohibited shipment of orgone accumulators in interstate commerce and the distribution of literature concerning orgone energy. Reich used his accumulator, pronounced worthless by the U.S. Food and Drug Administration, as an adjunct to psychiatric therapy. He maintained that a patient sitting in a box he devised could build up lost energy.

Scientists in the News

The U.S. Department of Agriculture has presented Distinguished Service Awards to seven of its employees for their achievements in research and improved administration. The recipients are as follows:

LYLE T. ALEXANDER, chief of the Soil Survey Laboratories, Soil Conservation Service, Beltsville, Md., who is a leader in soil science. He has done considerable work on the use of radioactive material in agricultural research and on the effects of radioactive fallout on soils.

MERTON R. CLARKSON, deputy administrator, Agricultural Research Service, Washington, who has played a major part in control and eradication of foot-and-mouth disease in Mexico during the past several years.

ELWOOD L. DEMMON, director of the Southeastern Forest and Range Experiment Station, Ashville, N.C., who has directed forest management work in several areas. Among his achievements is leadership in developing new methods of harvesting gum naval stores and in improving the management of several million acres of industrially owned forest throughout the pine region of the South.

CLARENCE M. FERGUSON, administrator, Federal Extension Service, Washington, who has promoted development of new extension educational methods for reaching and serving rural people.

JAMES B. HASSELMAN, director of information, Commodity Stabilization Service, who has spent nearly 40 years in state and federal agricultural information work. He now directs the information program that is required for the operation of acreage adjustments and price supports and for the sale, barter, and donation of Government-owned agricultural stocks.

SYLVESTER R. SMITH, director, Fruit and Vegetable Division, Agricultural Marketing Service, who provided the leadership and vision that resulted in a continuation of acreage and production guides for commercial growers after the war. These guides have helped to keep vegetable production in line with market needs.

PERCY A. WELLS, chief of the Eastern Utilization Research Branch, Wyndmoor, Pa., who directed research that led to development of new uses for many abundant farm products such as white potatoes, animal fats, and tobacco.

LEO E. MELCHERS, formerly head of the department of botany and plant pathology at Kansas State College, will retire from active duty on 1 July. He will have completed 43 years of service as teacher, administrator, and research worker at the college.

The National Science Foundation has announced that the U.S. Senate has confirmed the appointment of the following men to the National Science Board: EDWARD J. McSHANE, professor of mathematics, University of Virginia; SAMUEL M. NABRIT, president, Texas Southern University; JULIUS A. STRATTON, professor of physics and vice president, Massachusetts Institute of Technology; EDWARD L. TATUM, professor of biology, Stanford University; WARREN WEAVER, director, division of natural sciences, Rockefeller Foundation.

LAWRENCE M. GOULD, PAUL M. GROSS, GEORGE D. HUMPHREY, and FREDERICK A. MIDDLEBUSH, charter members of the board, were reappointed. Except for Weaver, all will serve terms of 6 years, ending 10 May 1962. The term of Weaver, who succeeds the late Rev. James B. Macelwane, expires 10 May 1960.

Four Albert Lasker medical journalism awards for outstanding reporting on medical research and public health during 1955 have been announced by the Albert and Mary Lasker Foundation in New York. In addition to awards for medical reporting in newspapers and general magazines, an award for television was included for the first time. It was given for "The March of Medicine," a documentary film and live-action series produced by Smith, Kline and French Laboratories, Philadelphia, over the National Broadcasting Company network. The individual winners, each of whom received $1000, are as follows:

SELIG GREENBERG, staff writer, the Providence (R.I.) *Journal and Evening Bulletin,* for his series of articles published in that paper during February 1955, on "Hormones: revolution in medicine."

JOAN GEYER, staff writer, the Provo (Utah) *Daily Herald,* for her series of articles published in her newspaper in May 1955 on "The secret sickness—mental illness."

STEVEN M. SPENCER, associate editor, the *Saturday Evening Post,* for his article, "Mystery of the blinded babies," published in the magazine, June 1955.

JOHN A. F. GERRARD, former director of geophysical research for Houston Technical Laboratories, is now director of geophysical research in the central research division of Texas Instruments, Inc., Dallas. In the Texas Instruments organization contract geophysical exploration is carried out by a subsidiary, Geophysical Service, Inc., which has eight affiliated companies throughout the world. The manufacture and marketing of geophysical instruments is conducted by Houston Technical Laboratories, another subsidiary. Gerrard replaced HAL J. JONES, who has been made chief engineer for the Houston facility.

DOROTHY F. BECK, who until recently has been assistant professor of biostatistics at American University in Beirut, Lebanon, has been appointed director of research for the Family Service Association of America. She will head an expanded research program in selected aspects of family case-work practices and policies. The association's 267 member agencies in this country, Canada, and Hawaii provide counseling services on personal and family problems for a million persons a year.

W. B. ENNIS, JR., agronomist for the Weed Investigations Section of the U.S. Department of Agriculture, has recently been transferred to the section's headquarters at the Plant Industry Station, Beltsville, Md. Since 1954 Ennis has served at State College, Miss., as southern regional coordinator for the Weed Investigations Section. At Beltsville he will assume the duties of project leader for weed control in horticultural and field crops.

Other recent personnel changes in the Weed Investigations Section include the appointment of EVERETT HOLLINGSWORTH as agronomist. He will be stationed at Lafayette, Ind., where he will cooperate with the department of botany at Purdue University. He will be concerned with weed-control practices in pastures and the establishment of forage crops for new pastures typical of the north-central region. Hollingsworth was formerly with the department of plant pathology and physiology of Mississippi State College.

M. M. SCHREIBER, previously a member of the agronomy department at Cornell University, has been appointed an agronomist for the section. He will be stationed at Ithaca, N.Y., where he will work in cooperation with Cornell. He will conduct research on the control of weeds in pastures and the establishment of forage crops for new pastures typical of the northeastern region. He will also be concerned with the establishment of pastures through the renovation of shallow soils throughout the northeastern states.

Another change is the transfer of LEONARD L. JANSEN to the Beltsville headquarters. Jansen was formerly assigned to physiological investigations of halogeton control at Logan, Utah, which are carried out in cooperation with Utah State College. At Beltsville he will continue physiological studies and will be primarily concerned with the mechanisms of herbicidal action.

BENGT O. ENGFELDT, professor of pathology at Uppsala University, Sweden, who studies the life cycles of bone tissue, has been named a visiting lecturer in the Harvard School of Dental Medicine. Engfeldt is chiefly interested in the normal construction and reconstruction of bone tissue and in the diseases and injuries that affect these processes. He is particularly concerned with the way in which bone tissue retains radioactivity and the effect this radiation may have on surrounding tissue, including the bone marrow.

ROSS G. HARRISON, Sterling professor of biology emeritus at Yale University, has received the Antonio Feltrinelli international prize of the Academia Nazionale dei Lincei of Italy. The 5-million-lira prize, worth about $8000 in U.S. currency, is awarded in the fields of science, the arts, music and literature.

The citation described as Harrison's principal contribution his discovery that tissues of the embryo, particularly those of the nervous system, can be grown outside the body. This led to his discovery that nerve fibers grow out from a certain specific region of the body and that they do not develop from the vague pathways of intercellular spaces, as had been believed previously.

Equally esteemed has been Harrison's work in developing the process of grafting together whole bodies of vertebrates or the parts and organs of different individuals or even of different species. He conducted experiments in grafting the limbs of one species of salamander to the body of another species.

Another Feltrinelli international prize winner is SOLOMON LEFSCHETZ, research professor of mathematics emeritus at Princeton University, who is at present serving as a professor in the Institute of Mathematics at the Universidad Nacional Autonoma de Mexico.

ARNIE J. SUOMELA, assistant director of the Fish and Wildlife Service, in charge of fisheries, has been promoted to the recently created post of associate director. In this capacity he will serve as general deputy to the director in directing the over-all activities of the service, including fisheries.

WILLIAM H. STEWART, chief of the Heart Disease Control Program, Division of Special Health Services, Bureau of State Services, Washington, D.C., has been appointed assistant director of the National Heart Institute, National Institutes of Health, Bethesda, Md. R. C. ARNOLD, chief of the Technical Services Branch, National Heart Institute, succeeds Stewart in the Bureau of State Services.

BERT R. BOONE, chief of the Labo-

ratory of Technical Development at the Heart Institute, has transferred to the Office of the Director, where he will serve as special projects officer. ROBERT L. BOWMAN of the Laboratory of Technical Development has become chief of the laboratory, succeeding Boone.

WALTER CARTER, head of the entomology department of the Pineapple Research Institute of Hawaii, will serve as consultant to the West African Cocoa Research Institute in Gold Coast for 3 months beginning 1 July.

R. J. STEPHENSON of the College of Wooster, Wooster, Ohio, has been appointed technical director of summer training for the Oak Ridge Science Demonstration Lecture Program of the Oak Ridge Institute of Nuclear Studies. Under this program, eight high-school science teachers will receive a special 3-month training course at Oak Ridge this summer and then spend the 9 months of the 1956–57 school year visiting high schools throughout the country, where they will present demonstration lectures to the science students and confer with faculty members on science-teaching problems.

LOTHAR W. NORDHEIM, professor of physics at Duke University since 1937, has joined the General Atomic Division of General Dynamics Corporation, San Diego, Calif.

J. ROBERT OPPENHEIMER, director of the Institute for Advanced Study at Princeton, N.J., received an award for "distinguished services to the principles of American democracy" during a dinner to celebrate the 11th anniversary of the founding of Roosevelt University, Chicago.

BASILE J. LUYET, professor of biology at St. Louis University, was honored recently on the 25th anniversary of his appointment to the faculty. To celebrate the occasion, the department of biology sponsored a lecture by ISIDORE GERSH, professor of anatomy at the University of Chicago, who discussed "Electron microscope studies of rapidly frozen tissues."

BRIG. GEN. JOHN R. WOOD has been named vice president and director of research for Burroughs Wellcome and Company, Inc. He will assume his new position on 1 Aug., when he retires from the U.S. Army Medical Corps. He is commandant and director of the Walter Reed Army Institute.

Wood received his medical degree from the Medical College of Virginia in 1928 and was honored by the same university with the degree of doctor of science in 1946. While a staff member at the Army Medical School in Washington from 1935 to 1939, he attended George Washington University, and in 1941 he received the M.A. degree in chemistry and biochemistry at Columbia University.

Wood has had a distinguished career in the Medical Corps. From 1943 to 1945 he was director of medical research at Edgewood Arsenal, Md., and from 1945 to 1950 he was chief of the Medical Division, Army Chemical Center. Prior to becoming commandant at the Walter Reed Institute, he was chairman of the Medical Research and Development Board, Office of the Surgeon General. Wood was decorated with the Commendation Ribbon in 1945 and with the Legion of Merit and the Oak Leaf Cluster in 1946.

Recent Deaths

CESARE BARBIERI, New York, N.Y.; 78; inventor of paper-cup-making machinery and machinery for manufacture of antifreeze; founder of the Cesare Barbieri Endowment; 25 May.

HAROLD K. BOX, Toronto, Canada; 66; researcher in tooth infection and gum diseases; professor emeritus of periodontology, University of Toronto; 24 May.

GEORGE C. DIEHL, New York, N.Y.; 83; consulting civil engineer in highway development; retired from the New York State Engineering Department; 26 May.

BRYON E. ELDRED, Lime Rock, Conn.; 83; physicist and inventor of a method of casting metals through the use of latent heat, the explosive nitrobyronel, and an instrument for curing deafness called the auditor; 26 May.

EDWIN M. HASBROUCK, Washington, D.C.; 89; physician and surgeon; former ornithologist at the Smithsonian Institution; 25 May.

ALFRED E. HUDSON, Washington, D.C.; 52; anthropologist and expert on Central Asian affairs; professor of anthropology at the University of Washington; 25 May.

LEWIS D. KNOWLTON, Hudson View Gardens, N.Y.; 81; former engineer for the Lamson Corporation; 24 May.

WILLIAM A. LUCAS, Elizabeth, N.J.; 71; consulting chemical engineer for the Peyton-Hunt Company, New York; 24 May.

WILLIS C. NOBLE, Jr., Montclair, N.J.; 71; biochemist; retired supervisor of the laboratory of the Metropolitan Life Insurance Company; 24 May.

JAMES M. OLMSTED, Berkeley, Calif.; 70; professor emeritus of physiology at the University of California and medical historian; important in the discovery of insulin; 25 May.

JOHANN RADON, Vienna, Austria; 69; mathematician; former rector of Vienna University; 26 May.

CARLTON P. ROBERTS, Springfield, N.J.; 53; partner and chief engineer for the New York architectural firm of Voorhees, Walker, Smith and Smith; 27 May.

CHARLES THOM, Port Jefferson, L.I.; 83; retired chief mycologist at the U.S. Department of Agriculture; first to identify the mold that led to penicillin; 24 May.

Education

■ The University of Illinois at Urbana has initiated a program by which teachers in elementary and secondary schools can obtain a master's degree in bacteriology within four summer sessions. A rotating program of advanced courses in microbiology will be offered by the bacteriology department. This program is part of an effort to introduce students to the field of microbiology as early as possible during their precollege training and to extend opportunities for training of teachers in various areas of science.

■ Harvard University is experimenting this summer with a new program to improve high-school science teaching. An 8-week course has been planned that is designed to refresh the scientific knowledge of a selected group of high-school science teachers. These teachers, in addition to stimulating the interest of their own high-school students, will teach other teachers of science from surrounding communities. The course will be offered under the auspices of the Harvard Summer School at the Harvard Medical School, with the collaboration of the Harvard Graduate School of Education.

■ Godfrey Nurse, the surgeon who 20 years ago led the drive to admit Negro physicians to Harlem Hospital in New York, has given the hospital $100,000 to establish a surgical research laboratory. Nurse has made the gift in the hope that a development program planned by Aubre de L. Maynard, surgery director, and his associates, will be fulfilled.

The new unit, the Godfrey Nurse Laboratory for Experimental Surgery, will provide surgical residents in the 4-year training course at the hospital with an opportunity to conduct research.

■ In the department of geology, Columbia University, Charles H. Behre, Jr., will be executive officer for the next 3 years. He succeeds Marshall Kay, who has completed a similar term.

Reports and Letters

Inherent Inconsistencies in Fluorescence and Scintillation Spectra

Various qualitative studies of emission spectra of liquid solution scintillators have been reported (*1*). Quantitative spectra have now been obtained from a number of solutions (*2*). The solutions, which were contained in cylindrical cells with lateral windows, were excited both with a 100-mc Cs^{137} source and with a mercury lamp directed to the top surface or to the front face of the cells. Densitometer tracings of the spectrograms, corrected for dispersion, for instrument and emulsion sensitivity, and for relative photon energy, provide spectra, the relative areas of which are proportional to the relative light-producing efficiencies of the solutions.

When another conversion factor for the spectral response of a photomultiplier cathode is applied, curves of relative number of photoelectrons plotted against wavelength are obtained. The relative areas of this type of curve obtained from scintillation spectra have been found to be in the same ratio as the relative pulse heights (*3*) of the scintillator solutions.

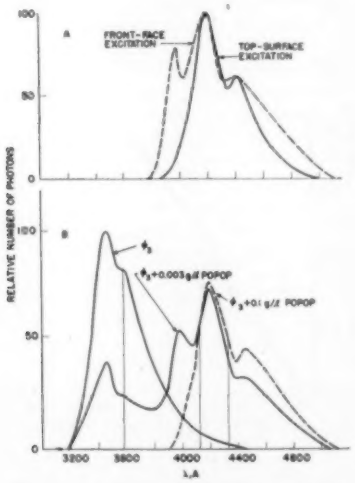

Fig. 1. (*A*) Fluorescence spectra of 4 g/lit ϕ_3 with 0.1 g/lit of POPOP in toluene; (*B*) scintillation spectra.

Illustration is provided in Fig. 1 by spectra that were obtained with the most efficient liquid-solution scintillator currently in use (*3*). Figure 1*A* shows the curves obtained by the two methods of ultraviolet excitation from a toluene solution of 4 g/lit of *p*-terphenyl (ϕ_3) with 0.1 g/lit of 1,4-di-[2-(5-phenyloxazoly)]-benzene (POPOP) (*4*) as secondary solute (wavelength shifter). The ordinate scale is in arbitrary units, and the curves are not comparable in this dimension. The shorter-wavelength peak at 4000 A is present with front-face excitation and not with top-surface excitation.

The front-face spectra remain practically the same in both intensity and structure as the POPOP concentration is varied from 0.1 to 0.001 g/lit; under overexposure conditions, the terphenyl spectrum is also present. The top-surface spectra in this range of concentrations do not show the terphenyl contribution even under overexposure conditions. The 4000-A peak is present at 0.01 g/lit and less. However, the over-all intensities of the spectra increase with decreasing concentrations of POPOP.

Figure 1*B* shows scintillation spectra from toluene solutions of 4 g/lit of ϕ_3 with varying concentrations of POPOP—namely, 0.1 g/lit, 0.003 g/lit, and no added secondary solute. These curves are comparable in this instance, being obtained under identical conditions, and the relative areas indicate the relative light-producing efficiencies of the solutions.

Also indicated by the vertical lines at 3580, 4120, and 4330 A in the figure for each scintillation spectrum is the mean wavelength, which is defined as that wavelength which divides the spectrum into two portions, each having an equal number of photons. This property is more significant when one is considering the usefulness of a compound as a secondary solute than the wavelength of the principal emission band. Concentrations of POPOP which are intermediate to the examples given here provide scintillation spectra that are intermediate in appearance. The effect of POPOP is still evident at 0.0001 g/lit.

Qualitatively, top-surface excitation spectra look like scintillation spectra for single-solute systems and for secondary solutes at concentrations where energy transfer from primary to secondary is complete. Thus, the more readily obtained spectra are useful for comparisons of spectral distribution of the light emitted from various scintillators. The relative intensities of spectra obtained by these two methods, however, are not the same. Relatively weak fluorescence spectra are provided by some of the better scintillators, which give scintillation spectra that correspond to their relative pulse heights.

One reason, of course, for these discrepancies is absorption, not only of the shorter-wavelength emission (*5*) but also of the exciting radiation before it reaches the volume of solution seen by the slit, and thus the relative intensities of spectra from various solutions will depend on the wavelength of exciting radiation, physical dimensions of the cell, and absorption properties of the solutions. The lack of correlation between fluorescence and scintillation spectra encountered under the afore-mentioned conditions certainly indicates that studies of scintillation processes by use of fluorescence techniques must be approached cautiously (*6*).

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References and Notes

1. F. X. Roser, *Science* **121**, 806 (1955) and references cited therein.
2. Work performed under auspices of the U.S. Atomic Energy Commission.
3. F. N. Hayes *et al.*, *Nucleonics* **13**, No. 12, 38 (1955); F. N. Hayes, D. G. Ott, V. N. Kerr, *ibid.* **14**, No. 1, 42 (1956).
4. F. N. Hayes, B. S. Rogers, D. G. Ott, *J. Am. Chem. Soc.* **77**, 1850 (1955).
5. R. K. Swank, *Ann. Rev. Nuclear Sci.* **4**, 119 (1954).
6. A paper concerned with additional studies and examples is in preparation.

13 January 1956

Microbiological Assay of Vitamin B_{12} in Marine Solids

We wish to report some experiments on methods for determining vitamin B_{12} in marine muds and in solids suspended in sea water using the *Escherichia coli* mutant 113-3 (*1*). The basal medium employed is the same as that used earlier (*2*) but without the addition of thioglycollate. Different investigators recently have used various reducing compounds (*3*) or cyanide (*4*) in the growth medium or in preparation of samples for microbiological assay.

It can readily be shown that the vitamin-B_{12} activity of marine materials is increased by boiling the materials for a few minutes in aqueous phosphate-citrate

buffer solution in a *p*H range of 5 to 6. Addition of sodium sulfite (Na_2SO_3), sodium bisulfite ($NaHSO_3$), sodium pyrosulfite ($Na_2S_2O_5$), or potassium cyanide (KCN), in small amounts results in further increased yields. A typical example is the following. Fifty milligrams of dried estuarine mud per 10 ml of phosphate-citrate buffer at *p*H 5.0 was extracted by boiling for 10 minutes with additions of 0.1-percent (weight per volume) sulfite or 0.005-percent cyanide. After centrifugation, the extracts were assayed with *E. coli* mutant 113-3. Typical results in micrograms of vitamin B_{12} per sample are as follows: buffer alone, 8.7; Na_2SO_3, 28.0; $NaHSO_3$, 27.5; $Na_2S_2O_5$, 25.0; KCN, 23.5. The increased yields obtained by adding sodium sulfite and the other compounds are outstanding.

Growth of *E. coli* 113-3 was studied in basal medium containing 1 mμg of vitamin B_{12} per tube and in the presence of different concentrations of cyanide or sulfites. The results (Fig. 1) indicate that toxicity is encountered with cyanide in still cultures at a concentration of about 10^2 μg/6 ml of medium and with sulfite at somewhat more than 10^3 μg/6 ml tube. When assays are being conducted on materials that are very low in vitamin content, it is important to avoid adding inhibitory amounts of substances when relatively large volumes of the sample extract have to be used. In order to avoid inhibition, not more than 1 mg of Na_2SO_3 may be present in 6 ml of the growth medium.

The relationship between the yield of vitamin B_{12} and the concentration of Na_2SO_3 in the extracting buffer is shown for aliquots of a sample of dried marsh mud in Fig. 2. It appears that the vitamin activity greatly increased with concentration of sulfite during the period of boiling the samples up to, and somewhat

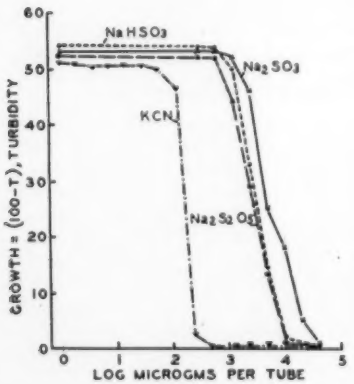

Fig. 1. Growth of *E. coli* 113-3 after 16 hours at 30°C in the presence of different amounts of $NaHSO_3$, Na_2SO_3, $Na_2S_2O_5$, and KCN in 6 ml of medium per tube.

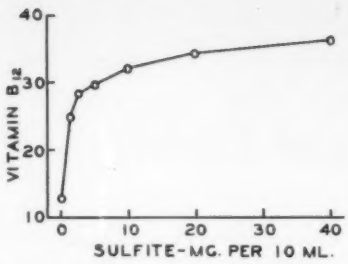

Fig. 2. Yields of vitamin B_{12} in samples of a marine mud extracted by boiling with different amounts of Na_2SO_3 added to each 50-mg sample in 10 ml of phosphate-citrate buffer at *p*H 5.0.

beyond, the level of about 20 mg of sulfite per 10 ml of buffer.

In order to ascertain whether sulfite or cyanide would show significant effects on the dosage response of *E. coli*, growth curves were determined for the assay organism in basal medium containing different levels of vitamin B_{12}, with and without addition of these substances (Na_2SO_3, 0.016-percent; KCN, 0.003-percent). It is obvious that KCN (in still cultures) is inhibitory, whereas with Na_2SO_3 the growth curve is indistinguishable from the standard curve obtained with increasing levels of vitamin B_{12} in the basal medium (Fig. 3). The similarity of the growth responses of *E. coli* to cobalamine in the presence and in the absence of Na_2SO_3 suggests that the increased vitamin-B_{12} activity found in natural samples extracted with sulfite does not come about through any direct effect on cobalamine or the growth response of the bacteria. Separate determinations with a specific methionine-requiring mutant show that methionine in the marine solids that we have studied is insufficient to interfere with the vitamin-B_{12} tests. *Escherichia coli* 113-3 does not respond to thymidine or to alkaline hydrolyzates of nucleic acid (*5*), and it seems probable that the sulfite effect comes about through better release of the bound vitamin B_{12}.

Assays were performed on marsh muds collected on Sapelo Island, Ga., and on suspended solids (detritus and plankton) that were filtered from surface samples of Duplin River water by use of type HA Millipore filters (*6*). The muds and filtered solids were air-dried at 30°C and placed in a desiccator. The dried filter, with its retained particles, was boiled for 10 minutes in 10 ml of phosphate-citrate buffer at *p*H 5.0. The suspension was then centrifuged to clarify, and the supernatant was assayed. Fifty milligrams of dried mud were extracted in 10 ml of boiling buffer, then centrifuged for clarification. The supernatant was assayed. Duplicated samples were treated with 0.05-percent Na_2SO_3 added to the buffer in order to determine the possible effect of sulfite upon assayable vitamin B_{12} activity. The resulting data on vitamin B_{12} in four sets of suspended particles were 7 times greater for the sulfite-treated extracts, and, in six sets of marsh muds, the results were 3.7 times greater for the sulfited extracts than for those treated in plain buffer. Sulfite-treated particles from the estuarine water averaged 17.5 mμg of vitamin B_{12} per liter of water, and sulfite-treated marsh muds average 328 mμg/g of dried material.

In order to determine the possible effect of heating the samples of filtered solids and marine muds during dehydration, an experiment was performed in which one part of a duplicated sample was dried at 100°C for 10 hours and the other was air-dried at 30°C. Several different samples of suspended solids and six samples of marsh muds were studied. After drying, all were stored in a desiccator for several days until assays could be made. The samples were then extracted by heating at 100°C with 0.1-percent Na_2SO_3 in phosphate-citrate buffer at *p*H 5.0. The results on suspended solids in both sets showed 5.8 mμg of vitamin B_{12} in material filtered from 1 liter of sea water. The vitamin B_{12} content of marsh mud, expressed as millimicrograms per gram, was 266 for mud dried at 100°C and 481 for the same mud dried at 30°C.

These data indicate that the suspended matter (detritus and plankton) that was collected by Millipore filtration of estuarine waters contains assayable levels of vitamin B_{12} and that the assays are not altered by drying the samples at 100°C for 10 hours. Appreciable amounts of vitamin B_{12} are present in marsh muds. Dehydration of mud at 100°C apparently causes some deterioration in the assayable

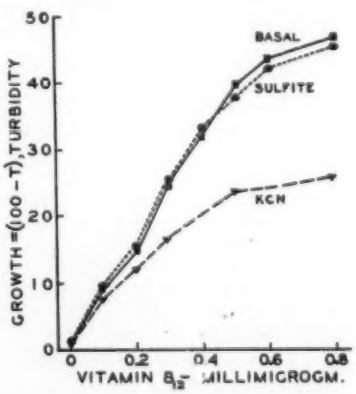

Fig. 3. Growth of *E. coli* 113-3 in response to different levels of vitamin B_{12} in basal medium alone, and with 0.016-percent Na_2SO_3, and 0.003-percent KCN added to the medium.

vitamin content. It seems probable that smaller quantities of mud could be dried rapidly at 100°C without loss in vitamin-B_{12} activity (*7*).

Our attempts to perform direct assays on dissolved vitamin B_{12} in sea water have not been successful thus far, even with *E. coli* that was especially adapted to high salinity. This aspect of the problem is being examined with studies on other bacteria that may prove more suitable for the task.

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References and Notes

1. These studies were aided by a contract between the Office of Naval Research, Department of the Navy, and the University of Georgia, NR 163 308.
2. P. R. Burkholder, *Science* 114, 459 (1951).
3. H. R. Skeggs *et al.*, *J. Biol. Chem.* 184, 211 (1950).
4. E. Harrison, K. A. Lees, F. Wood, *Analyst* 76, 696 (1951); H. G. Wijmenga, W. L. C. Veer, J. Lens, *Biochim. et Biophys. Acta* 6, 229 (1950); D. C. Hine, M. C. Dawbarn, J. Smith, *Australian J. Exptl. Biol. Med. Sci.* 33, 349 (1955).
5. B. D. Davis, *Proc. Natl. Acad. Sci. U.S.* 35, 1 (1949).
6. Millipore Filter Corp., Watertown, Mass.
7. A more detailed report of these investigations is in preparation.

16 January 1956

Suppression and Modification of Virus-Induced Rous Sarcoma in Chicks by Xerosin

This report (*1*) presents data showing that parenteral injections of xerosin both suppressed and modified virus-induced Rous sarcoma in chicks and that the effectiveness of xerosin was markedly influenced by the initiating dose of Rous sarcoma virus (RSV). This observation is of particular interest because it has been previously shown (*2*) that the amount of RSV extractable from a given tumor was directly related to the amount of RSV used to initiate that tumor. Indeed, when high dilutions of RSV were employed which produced tumors in less than 50 percent of the inoculated chicks, about 24 percent of such low-dose tumors yielded no extractable virus at all. Further, the latent period of tumor response (*2–4*) and the rate of growth of the tumor (*2*) were also found to be related to the initiating dose of RSV (*3*).

Stable, standard, frozen inocula of RSV (*5*) were used. The bacterial product, xerosin, was prepared as previously described (*6*). Suitably diluted RSV in 0.2-ml amounts was inoculated subcutaneously into the wing web of unsexed white leghorn chicks 2 to 5 days of age. Single daily injections of 100 mg/kg of xerosin were injected intramuscularly in the leg. Each chick was examined daily. The data were analyzed graphically as previously illustrated (*4*, *7*) for data of this type.

Table 1 shows the effect of the initiating dose of RSV on the effectiveness of xerosin in modifying tumor response. Chicks were injected daily with xerosin or saline, respectively, beginning 2 days before inoculation of RSV. The data show that, when chicks were inoculated with dilute RSV (for example, 10^{-6}), xerosin prolonged the latent period more effectively, and the incidence of atypical tumors was markedly greater. The most striking effect of xerosin on Rous sarcoma was the greatly increased incidence of atypical tumors. Typical tumors were soft, grew rapidly, and were grossly invasive, while the xerosin-induced atypical tumors were hard, sharply circumscribed, and grew slowly. A representative typical and atypical tumor are pictorially presented in Fig. 1.

Daily injections of xerosin were discontinued 3 weeks after inoculation of RSV in 10 chicks with atypical tumors, and these chicks were examined daily for 2 additional weeks. These atypical tumors continued to grow slowly, but none reverted to a typical grossly invasive tumor. Next, each of these atypical tumors was removed and each was mascerated with sand in a mortar, suspended in 9 volumes of saline, and clarified by centrifugation, and each suspension was inoculated subcutaneously into groups of 10 chicks each. Three weeks later, the results clearly indicated that each atypical tumor contained virus that produced typical invasive tumors after subinoculation.

Modification of the Rous sarcoma was also effected when daily injections of xerosin were delayed until the day on which typical small but grossly visible tumors appeared in the wing web. In this experiment, 300 chicks were inoculated in the wing web with RSV diluted 10^{-6}. One-half of the chicks were set aside for injections of xerosin and the other half for saline. Daily intramuscular injections of xerosin or saline were begun for each chick, individually, on the day when a tumor 3 mm or more in diameter appeared in the translucent wing web. Four weeks after inoculation of RSV, 98 of 150 chicks in the control group had well-established tumors, 15 percent of which were atypical, while 101 of 149 chicks in the xerosin-treated group had well-established tumors, 57 percent of which were atypical. It is clear that the incidence of xerosin-induced atypical tumors was almost identical whether daily injections of xerosin were begun before inoculation of low doses of RSV or delayed until the tumors first appeared in the wing web.

Table 1. Effect of initiating dose of RSV* on modification of tumor-response in chicks by xerosin.

Standard RSV diluted (log)	Daily intramuscular injection of	Tu/T†	Mean latent period‡ (days)	Atypical tumors (%)
−6	Saline	31/39	7.0	8§
−6	Xerosin‖	18/31	11.3	52
−5	Saline	39/40	6.7	3
−5	Xerosin	30/32	7.9	8
−4	Saline	40/40	6.1	0
−4	Xerosin	25/27	6.7	0

* RSV—Rous sarcoma virus (chicken tumor I agent).
† Tu/T = Number of chicks with tumors/total.
‡ Mean latent period = time in days to produce grossly visible tumors in 50 percent of chicks.
§ Slow-growing, circumscribed tumors may also occur in untreated chicks inoculated with small doses of RSV.
‖ 100 mg/kg day beginning 2 days before RSV.

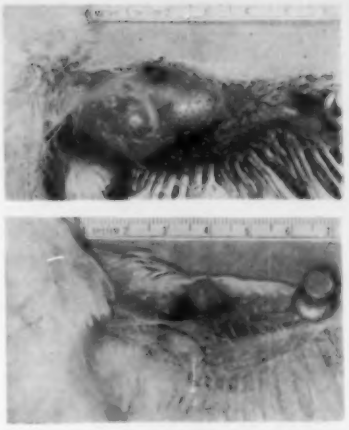

Fig. 1. Typical and xerosin-induced atypical tumors 19 days after inoculation of approximately 10 ED_{50} of RSV. (Top) typical; (bottom) atypical.

There is a striking similarity between the gross appearance of the atypical tumors induced by xerosin (Fig. 1) and those induced by hydrocortisone (*8*). However, the latter promptly reverted to typical invasive tumors when hydrocortisone was discontinued, and, when injections of hydrocortisone were begun after inoculation of RSV, the tumors were not only typical but also grew more rapidly than control tumors. Ginsberg (*9*) has shown that, while both xerosin and cortisone beneficially modify pneumonia that has been induced in mice by chemical irritants, only xerosin beneficially modifies pneumonia in mice that are infected with mouse-unadapted influenza virus. Despite the fact that xerosin lacks any antiviral or other antimicrobial activity whatever (*6*, *9*), and therefore cannot be classified as an antibiotic, xerosin was found to beneficially modify disease induced in mice by the

pneumotoxicity of Newcastle disease virus (*10*) and by the neurotoxicity of influenza virus (*11*).

To the extent that the Rous sarcoma is typical of other virus-induced tumors, it is important that tumor response to at least one chemotherapeutic agent is greatly influenced by the amount of virus used to initiate the tumor.

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References and Notes

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2. W. R. Bryan, D. Calnan, J. B. Moloney, *J. Natl. Cancer Inst.* 16, 317 (1955).
3. W. R. Bryan, *ibid.* 6, 373 (1946).
4. ———, *ibid.* 16, 843 (1956).
5. W. R. Bryan, J. B. Moloney, D. Calnan, *ibid.* 15, 315 (1954).
6. V. Groupé *et al.*, *J. Bacteriol.* 68, 10 (1954).
7. V. Groupé *et al.*, *J. Natl. Cancer Inst.* 16, 865 (1956).
8. V. Groupé, F. J. Rauscher, W. R. Bryan, *Proc. Soc. Exptl. Biol. Med.* 91, 113 (1956).
9. H. S. Ginsberg, *J. Immunol.* 75, 430 (1955).
10. V. Groupé, L. H. Pugh, A. S. Levine, *Science* 118, 187 (1953).
11. V. Groupé and E. C. Herrmann, Jr., *J. Immunol.* 74, 249 (1955).

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25 April 1956

On the Intimate Composition of Membranes of the Inner Ear

In 1953 (*1*), autoradiographic studies of radiosulfate incorporation by the inner ear were conducted in our laboratory. This work revealed a relatively high uptake by the membrana tectoria and also by the gelatinous mass of the cupula, while the otolithic membrane of the macula recorded a lower concentration. Radiosulfate ($S^{35}O_4$) was also detected in all three membranes by Ringertz (*2*), who used a similar approach. Furthermore, our ethanol-formalin fixed, undecalcified tissues stained metachromatically with toluidine blue in all the areas that have revealed an uptake of radiosulfate (*3*) including the inner-ear membranes (*1*). These results seemed to indicate that the radiosulfate was retained as newly synthetized sulfomucopolysaccharides.

Recently, Wislocki and Ladman (*4*) have challenged this hypothesis on the basis of studies of decalcified newborn-mouse tissue fixed in lead acetate or Zenker's acetic acid fluid which revealed no metachromasia. On the other hand, those authors have obtained a positive result with the Barrnett and Seligman test for SH_2 and S—S groups and conclude that the uptake of S^{35} which we had observed might be explained by the formation of disulfide groups associated with cystine.

If there was a concentration of sulfur-containing amino acids in the inner ear membranes, such as is encountered in keratinized tissues, S^{35}-labeled cystine or methionine (*5*) would be expected to produce a more intense autoradiographic reaction in these sites than $S^{35}O_4$, for the amount of cystine and methionine biosynthesized from sulfate in mammalian tissue is known to be very small (*6*).

While currently conducting a general survey of uptake of S^{35}-labeled methionine and cystine (*7*), we have had the opportunity to observe several specimens of the inner ear in rats labeled at 8 days of age and sacrificed at intervals of 1, 2, and 6 hours and 1, 2, and 4 days thereafter (*8*). The histoautoradiographic processing has been the same as previously reported for the radiosulfate series (*1, 3*). The tissues that are known to contain keratin—the epidermis, hair, and tooth enamel—revealed a high uptake of labeled amino acids.

Although cystine is the most important sulfur-containing amino acid of the keratins, it has been shown by Tarver and Schmidt (*9*) that when labeled methionine is introduced into an experimental animal, a large proportion of the radioactive sulfur appears in crystallized cystine from hair and skin. This is an indication that there is conversion from methionine to cystine at the level of the tissues. The other structures, synthetizing proteins with a low concentration of sulfur-containing amino acids, showed a much lower graded uptake, which was assumed to be proportional to the local rate of synthesis (*7*).

The inner ear, by comparison with other regions of nonspecific uptake such as the bone (Fig. 1), is definitely an area of low concentration, producing an autoradiographic record only after exposures of several months. Within this structure, certain features such as the area vasculosa and the spiral lamina appear to be more active than the general tissue background. On the other hand, the tectorial membrane (Fig. 1, arrows), the cupula, and the otolithic membrane were constantly negative.

These results must be compared with the large concentration of $S^{35}O_4$ previously reported (*1*) and presumably bound to large polysaccharide molecules. Furthermore, it has been possible to reproduce on the present material, with or without demineralization, the strong periodic acid-Schiff staining of the membranes that was described by Wislocki and Ladman (*4*).

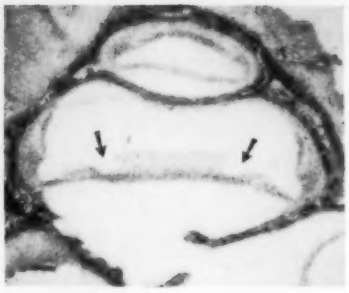

Fig. 1. Integrated autoradiogram of the cochlea of a 9-day-old rat, 24 hr after an injection of S^{35}-methionine (×29). The organ of Corti shows a general low uptake. The tectorial membrane (arrows) is negative.

It seems evident that the inner-ear membranes contain a large amount of polysaccharides and that these are at least partly sulfated. On the other hand, as compared with the skin, hair, and enamel, the inner-ear membranes synthetize virtually no protein from S^{35}-methionine.

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References and Notes

1. L. F. Bélanger, *Science* 118, 520 (1953).
2. N. R. Ringertz, Karolinska Institute, Stockholm, Sweden, personal communication (1955).
3. L. F. Bélanger, *Anat. Record* 118, 755 (1954).
4. G. B. Wislocki and A. J. Ladman, *J. Anat.* 89, 3 (1955).
5. The labeled amino acids were purchased from Abbott Radiochemicals, North Chicago, Ill.
6. H. Boström and S. Gordell, *Acta. Chem. Scand.* 7, 216 (1953).
7. L. F. Bélanger, *Anat. Record*, in press.
8. I am indebted to Cécile Bélanger for technical collaboration and to the Medical Division of the National Research Council of Canada for a grant-in-aid.
9. H. Tarver and C. L. A. Schmidt, *Proc. Soc. Expl. Biol. Med.* 41, 442 (1939).

16 January 1956

Effect of Sensory Deprivation on Learning Rate in Human Beings

Recent theoretical considerations (*1*) concerning brain functioning have so emphasized the necessity for constant sensory bombardment in order to maintain normal, intelligent, adaptive behavior that it is only natural to speculate about the effects of reduced sensory stimulation. As interesting as it might prove to be, it is obviously not possible to stop completely all sensory input and still maintain a responsible observer. It is possible, however, by rigid conditions of confinement, to minimize not only the amount of sensory input but also to bring about a drastic reduction in its variability. Such a condition of confinement, to be

described in detail, has been termed *sensory deprivation*, a term more convenient than accurate.

The first systematic investigation of the effects of confinement on human subjects was carried out at McGill University by Bexton, Heron, and Scott (*2*). In that study the conditions of confinement emphasized the reduction of variability in sensory stimulation. The subjects wore semitranslucent goggles through which they could make out brightness but could not form discriminations. There was constantly present a masking noise which served to minimize the effectiveness of sound from outside the cubicle. Each subject wore cardboard gauntlets that extended from just below the elbow to beyond the fingertips. The subjects were confined under such conditions for various periods of time up to 5 days. It was found that in tests of cognitive ability, continued isolation produced inferior performances, later referred to as deterioration of the intellect (*3*), which fortunately disappeared upon the subject's release from confinement. Confinement also produced in all subjects hallucinations that were mostly auditory or visual, but in one case tactual. Immediately upon being released from confinement, subjects reported difficulty in focusing, as well as a tendency to perceive the environment as two-dimensional, with colors more saturated than usual. They also reported that during confinement there was an inability to sustain extended thought.

The present study is preliminary in nature (*4*) and was not intended as a replication of the McGill study. The confinement conditions are very dissimilar. The Princeton study was conducted in the following manner: Four male college seniors served as subjects under conditions of confinement and isolation for a period of 48 hours. Isolation was provided by a floating room (15 ft by 9 ft), which was lightproof, and through which there was an 80-db sound loss. Subjects were fitted with ear plugs and instructed to make as little noise as possible while they utilized free access to a bed and a chair. The confinement cubicle was only 4 ft by 9 ft, which allowed little activity. Further restriction of activity was provided, as in the McGill study, in the form of cardboard gauntlets. The confinement period was interrupted only for meals, tests, and toilet needs. For meals and tests, subjects were removed from the isolation cubicle to the antichamber of the floating room, where a 15-w red bulb provided illumination when necessary. Lightproof goggles were used when the subjects attended to toilet needs outside the confinement cubicle. During the interruptions, no conversation was allowed except that necessary for the conduct of tests. Smoking was permitted at these times.

Inasmuch as the McGill study had found that confinement affected cognitive ability adversely, it was decided in the present study to test the effects of sensory deprivation on learning rate. The learning tasks were 12-item adjective lists, presented aurally. A subject's ability to learn by the anticipation method with a 2-second interstimulus interval was determined before confinement, after 24 hours of confinement, after 48 hours of confinement, 24 hours after release from confinement, and 48 hours after release from confinement. All tests were conducted in the antichamber of the floating room to render all distractions relatively constant.

Figure 1 presents the effects of sensory deprivation on the ability to learn adjective lists, indicating mean values for the four subjects. The results clearly indicate that the ability to learn adjective lists improves with continued sensory deprivation. That this improvement is not a function of either the particular adjective lists or a learning how to learn is indicated by the performance of a control group.

Attempts to measure the effect of sensory deprivation on suggestion, by the Hull body-sway technique, proved unsuccessful.

Upon release from confinement, the subjects were required to give full accounts of the confinement experience, which was recorded on tape. They were then questioned about any of the following items that they had not mentioned: hallucinations, focusing difficulty, lack of ability to engage in extended thought, increased saturation of hues, and lack of three-dimensional perception. In each case, the subject's report was contrary to the McGill findings.

It would be unwise to stress the differences between the McGill and Princeton findings in view of the few subjects used in the latter case. However, it is possible that the differences in the confinement conditions were in part responsible for the divergent results. For example, it may have been that hallucinations were actually generated in the McGill study by the amorphous visual stimuli or the repetitious masking noise or both. Furthermore, these same stimuli may have served as distractions contributing to the decrease in the general mental performance of the McGill subjects.

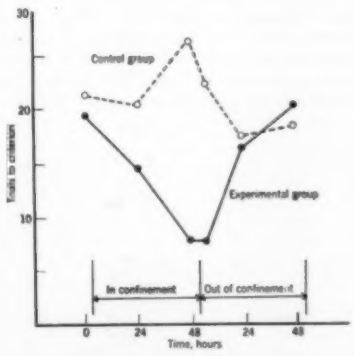

Fig. 1. Effect of sensory deprivation on learning rate in human beings. Each point is the mean value of four subjects.

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References and Notes

1. W. G. Walter, *The Living Brain* (Norton, New York, 1953).
2. W. R. Bexton, W. Heron, R. H. Scott, *Can. J. Psychol.* **8**, 70 (1954).
3. D. O. Hebb, E. S. Heath, E. A. Stuart, *ibid.* **8**, 152 (1954).
4. The investigation of sensory deprivation is now continuing under a contract between Princeton University and the Office of the Surgeon General of the Department of the Army.

2 February 1956

Nature of Protein Synthesis in Sweetpotato Infected with Ceratostomella fimbriata

An increase in respiratory rate is commonly observed in the tissues of seed plants when they are infected by pathogens (*1*), and we have found that in sweetpotato infected with *Ceratostomella fimbriata* (black rot), the rate of respiration of the sound tissue adjacent to the area in which the pathogen has developed is higher than that of a control (uninfected sweetpotato). The increase was accompanied by anabolic events, as shown by the accumulation of organic phosphate (P_o) and the synthesis of protein (*2*).

A description of a possible mechanism for the respiratory increase follows. As a result of the penetration of the fungus, the protoplasm of the sound tissue next to the infected area is stimulated to synthesize P_o and protein, and, concomitantly, the reaction

$$ATP \rightarrow ADP + P$$

is accelerated, resulting in an increase in respiratory rate. The details of this metabolic stimulation and protein synthesis are examined in this report (*3*).

To determine the pattern of protein synthesis, slices (1 cm thick) were cut from sweetpotatoes. Some of the slices were inoculated with a spore suspension of *C. fimbriata*; the rest served as a control sample. The sound tissue adjacent to the infected areas in the inoculated sample, which is referred to as tissue A, was removed after 48 hours. Sound tissue (referred to as tissue B) was also ob-

Table 1. Amounts of RNA-phosphorus and protein in the cytoplasmic fractions of sliced sweetpotato tissue. Values are expressed in micrograms per gram of fresh tissue.

Measurement	Mw	Pw	S_2	Total
RNA-P of sound tissue from infected slices (A)	1.84	3.54	13.0	18.38
Protein of sound tissue from infected slices (A)	88.0	74.5	390.0	552.5
RNA-P of sound tissue from uninoculated slices (B)	1.74	2.01	14.5	18.25
Protein of sound tissue from uninoculated slices (B)	66.7	47.3	309.0	423.0

tained from the control sample. Both kinds of tissues were then treated in the following fashion.

The tissues were homogenized with 0.25*M* sucrose solution and, after a low-speed centrifugation to remove sediment such as nuclei, starch granules, and the debris of cell walls, the supernatant was fractionated according to Schneider's method (*4*) into three parts: mitochondria (Mw), microsomes (Pw), and supernatant (S_2). Protein nitrogen and ribonucleic acid (RNA) were determined by micro-Kjeldahl digestion and by the modified method of Ogur (*5*), respectively. As is shown in Table 1, protein nitrogen in every fraction of the tissue was higher in the sound parts of infected slices (tissue A) than in corresponding tissue from untreated control slices (tissue B), but the total amount of RNA was the same. However, it can be seen that in tissue A the amount of RNA in the smaller particles (designated as the microsomal fraction) had increased at the expense of the supernatant. Recent studies have led to the conclusion that the microsomes, rich in RNA, are the site of all of the protein synthesis in the cells (*6*). On the basis of these investigations, it may be suggested that the growth of the pathogen in the sweetpotato leads in some manner to a stimulation of synthetic activity (as shown by the large increases in protein in each cell fraction) in adjacent parts of the sweetpotato tissue that are not infected.

The possibility that the observed increases in protein might be due in part to the synthesis of enzyme protein was investigated by comparing the oxidative activity of mitochondrial fractions prepared from tissues A and B.

It is clear (Table 2) that tissue A was superior to tissue B by each of the criteria utilized. The rate of oxygen uptake in mitochondria from the sound part of infected slices was about twice that in those from uninfected slices, and phosphorylative activity was also greater. There was a greater amount of protein nitrogen in the preparation from tissue A, but despite this, the activity of the mitochondria of tissue A (expressed as oxygen uptake per milligram of nitrogen, per hour), was higher than in those from tissue B. The greater intrinsic activity of the mitochondria may be one factor contributing to the higher respiratory rate that has been observed in the intact tissue from which the mitochondria were derived. The P/O value for oxidative phosphorylation was higher in tissue A than in tissue B, but it was lower in both cases than it was in the mitochondria prepared from the tissue of fresh sweetpotato (that is, one which had remained unsliced and untreated). This might be attributed to difficulties experienced in the preparation of the mitochondria which results from the oxidation of polyphenols by a polyphenol oxidase that increases in the tissues when the sweetpotato is sliced or infected (*8*).

It would thus appear that increases in the amount of mitochondrial enzymes (functional protein) do occur in parts of slices adjacent to infected areas and contribute to the protein recovered in this fraction. In addition, however, the intrinsic activity of the mitochondria is apparently increased.

Table 2. Respiratory oxidation and oxidative phosphorylation by mitochondria from sweetpotato. The reaction mixture contained 20 μ*M* phosphate buffer at *p*H 7.2; 200 μmoles of sucrose; 20 μmoles of α-ketoglutaric acid; 100 μmoles of glucose; 3 μmoles of ATP, 10 μmoles of $MgCl_2$; 10 μmoles of Versene; 20 μmoles of NaF; and 1 ml of enzyme in a total volume of 2.3 ml. The mixture was incubated in Warburg vessels for 60 minutes at 30°C. The mitochondria were prepared according to a previously described method (*7*), using 45 g of each tissue, and finally they were suspended in 3 ml of the 0.5*M* sucrose solution containing 0.02*M* phosphate buffer and 0.2*M* NaF as a phosphatase inhibitor.

Source of mitochondria	Uptake (μatom/flask, per hr)		P/O	Protein N (μg/flask)	O_2 uptake (μatom/mg of N, per hr)
	O_2	P			
Tissue A (sound) from infected slice 48 hr after cutting	6.7	3.6	0.54	577	11.6
Tissue B (from uninoculated control slice) 48 hr after cutting	3.6	0.59	0.16	419	8.6
Tissue A 72 hr after cutting	7.61	3.2	0.42	595	12.8
Tissue B 72 hr after cutting	2.77	0	0	426	6.5
Fresh sweetpotato	2.0	2.15	1.08		

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References and Notes

1. P. J. Allen, *Phytopathology* **43**, 221 (1953).
2. T. Akazawa and I. Uritani, *Nature* **176**, 1071 (1955).
3. I wish to express my gratitude to I. Uritani, Nagoya University, for his helpful advice.
4. W. C. Schneider and G. H. Hogeboom, *J. Biol. Chem.* **183**, 123 (1950).
5. M. Ogur and G. Rosen, *Arch. Biochem.* **25**, 262 (1950).
6. Y. Oota and S. Osawa, *Biochim. et Biophys. Acta* **15**, 163 (1954); V. Allfrey, M. M. Daly, A. E. Mirsky, *J. Gen. Physiol.* **37**, 157 (1953).
7. T. Akazawa and I. Uritani, *J. Biochem. Japan* **41**, 631 (1954).
8. I. Uritani and T. Akazawa, *J. Agr. Chem. Soc. Japan* **27**, 789 (1953).

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28 December 1955

New Insoluble Active Derivative of an Enzyme as a Model for Study of Cellular Metabolism

It has long been recognized by those interested in cytochemistry and cell physiology that an interface would be the preferred model structure for the study of certain enzymatic reactions (*1*). If the enzyme forms the surface of a stationary phase and the substrate is dissolved in the adjacent liquid or mobile phase, the system simulates conditions inside a living cell (*2*). Other conditions which are imposed on such an ideal working model are that the enzyme is not inactivated in forming the model and that the model responds to environmental changes.

In these studies, catalase was combined with cellulose anion exchanger; this combination was enzymatically active. It is believed that this is the first recorded demonstration of an active derivative of an enzyme resulting from the electrostatic interaction of the enzyme and an insoluble polyelectrolyte. The new derivative is remarkable because of the ease with which the soluble enzyme can be liberated.

The new catalase-cellulose form can be easily demonstrated with crude or crystalline preparations of catalase and

a weak cellulose anion exchanger. The insoluble derivative of catalase retains a high order of enzymatic activity which, according to estimates, is as high as 70 percent of that of its soluble form (*3*). No measurable amount of enzyme is removed by washing with water, but the solubility of the enzyme is affected by a shift in *p*H or an increase in the ionic strength of the surrounding solution. Certain other proteins can displace the enzyme, whereas the substrate, hydrogen peroxide, is acted upon but does not appear to free the enzyme.

Preparation of the catalase derivative was accomplished as follows. A column of 1 g of cellulose anion exchanger (0.2 to 0.5 milliequivalent/g, *4*) as the free base was reacted with 10 Keil units (*5*) of purified liver catalase (*6*) in 10 ml of water. This product was washed with many volumes of distilled water. The catalase-cellulose was exposed to 3 to 6 percent hydrogen peroxide solution at the maximum rate at which the solution could flow through the column. No hydrogen peroxide was detected in the effluent. The catalase continued to function for 4 days at room temperature—tests were made for several hours each day—without any visible decrease in the evolution of oxygen. At the end of this period, the catalase was desorbed by the addition of salt solution. A green band moving down the column corresponded to the active enzyme. This type of experiment was repeated more than 20 different times with slight variations.

Catalase preparations containing salts, acids, or other proteins require larger amounts of exchanger to react with a corresponding amount of the enzyme. The width and intensity of the colored band on a column of exchanger depends on the concentration and purity of the enzyme. Purification can be effected by selective elution. The mild nature of the cellulose exchanger for purification of catalase is demonstrated by the quantitative recoveries of soluble catalase that one can accomplish while working at room temperature over a period of several days.

One can speculate that some insoluble enzymes in the cell function in a state similar to this catalase-cellulose form. Nucleic acids, structural proteins, mucopolysaccharides, or phospholipids may serve as ion-exchange agents in the cell. Enzymes that are not active as the insoluble derivative with these "natural" ion exchangers might be activated by at least two different mechanisms. Some of these insoluble derivatives could be solubilized by the substrate. For example, cathepsin of kidney was liberated from its protein nucleates by a peptide (*7*). The product of the enzyme action may not maintain the enzyme solubility in the presence of the polyelectrolyte; in this case, the insoluble derivative is reconstituted. Removal of the product could have the same end-result.

Other environmental changes, such as local changes in *p*H or ionic strength in the cell, may be even more important in releasing electrostatically bound enzymes. Some support for this model is that carbon dioxide can dissociate many of these insoluble protein-cellulose ion-exchanger derivatives (*8*). Selective permeability of the cellular membranes to substrates and other ions, together with some system of insoluble polyelectrolyte derivatives of enzymes, may be responsible for control of enzymatic processes. This new model, although admittedly crude, might lead other workers to a better understanding of cellular metabolism.

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References and Notes

1. For a critical review and evaluation of other model systems see D. F. Cheesman and J. T. Davies, *Advances in Protein Chemistry IX* (Academic, New York, 1954), p. 498.
2. H. J. Trurnit, *Arch. Biochem. and Biophys.* 47, 251 (1953).
3. S. Lerner of Armour Laboratories conducted the quantitative studies.
4. The 2-N,N-diethylaminoethyl ether of cellulose as described by D. L. Hoffpauir and J. D. Guthrie, *Textile Research J.* 20, 617 (1950); and H. A. Sober and E. A. Peterson, *J. Am. Chem. Soc.* 76, 1711 (1954).
5. Keil unit = 0.1 g H_2O_2 decomposed per minute.
6. Armour and Co.
7. H. R. Gutmann and J. S. Fruton, *J. Biol. Chem.* 174, 851 (1948).
8. M. A. Mitz and S. S. Yanari, *J. Am. Chem. Soc.* 78 (5 June 1956).

18 January 1956

Protection against Clostridium perfringens Type A Toxin by a Metal-Chelating Compound

The alpha toxin of *Clostridium perfringens* type A is an enzyme, a lecithinase (*1*), and there is evidence that it is the most important lethal factor in infections caused by this organism (*2*). This enzyme is activated by calcium, and it was hypothesized that, if the calcium were removed from the area of an infection, the ability of the organisms to spread and cause death would be decreased. In an attempt to test this hypothesis, a lethal dose of organisms was mixed with sodium oxalate and sodium citrate and injected intracutaneously into mice, but there was no decrease in mortality (*3*).

In an extension of this work, ethylenediamine tetraacetic acid (EDTA) (*4*), a metal-chelating agent, was used as a calcium-binding agent in the manner described in the previous paragraph. On a number of occasions this compound was able to prevent death following the injection of a lethal dose of organisms, but the results are not reproducible at will. This variability is thought to be due to marked variations in the virulence of the test organism, and further studies are being carried out to see whether it is possible to establish conditions whereby protection by EDTA can be readily demonstrated.

However, it has been found that EDTA consistently protects mice against a lethal dose of *C. perfringens* type A toxin, and this report deals with the work that has been carried out thus far with the toxin (*5*).

In the experiments described here, 0.5 ml of a 1 to 4 dilution of a toxic culture filtrate (*6*) was injected intracutaneously into white mice that weighed 20 to 25 g. This dose contained 2 M.L.D. and killed mice within 10 hours. In the initial experiments, groups of ten mice were injected with the following mixtures: (i) 1 vol of toxin plus 3 vol of borate-buffer (BB) (*7*) and (ii) 1 vol of toxin plus 1 vol of BB plus 2 vol of 0.68-percent EDTA in BB. All the animals in the first group died, and none in the second group died.

In an attempt to reverse the protective effect of EDTA, $CaCl_2$ was added to an EDTA-BB solution until a precipitate formed on the addition of sodium oxalate, indicating the presence of free Ca^{++}. The calcium-saturated EDTA protected mice to the same extent that EDTA alone did. However, when Zn^{++}, Co^{++}, and Mn^{++}, which also activate lecithinase (*8*), were added to the toxin-EDTA mixture, the toxicity was restored.

These metal ions were tested for their ability to reverse the protective action of EDTA by injection of the following mixtures into groups of ten mice, in addition to those previously mentioned: 2.5 vol of toxin plus 5 vol of 0.68-percent EDTA plus 1.5 vol of BB plus 1 vol of 0.135*M* solutions of $CaCl_2$, $ZnCl_2$, $CoCl_2$, and $MnCl_2$, respectively.

The amount of metallic salt that was added in each case was not quite twice the amount that could be chelated by the EDTA present. The mice that received the toxin-EDTA and toxin-EDTA-$CaCl_2$ mixtures survived, whereas those that received toxin alone or the toxin-EDTA plus either $ZnCl_2$, $MnCl_2$, or $CoCl_2$, died. The various salts used, the EDTA, and the mixtures of EDTA and the salts had no apparent effect on mice when they were injected separately.

When the effects of these salts were tested for their ability to reverse the *in vitro* inhibition of lecithinase with the lecithovitellin test, the results paralleled those obtained *in vivo*. EDTA inhibited the lecithovitellin reaction. An excess of either Zn^{++}, Co^{++}, or Mn^{++} reversed this inhibition, and an excess of Ca^{++} did not

reverse it. Preliminary experiments utilizing the manometric technique of Zamecnik *et al.* (*8*) for the determination of lecithinase have yielded identical results.

These results suggest that Ca^{++} activates but is not essential for the activity of lecithinase whereas Zn^{++}, Co^{++}, and Mn^{++} activate and are essential for the activity of the enzyme. They can be explained on the basis that Zn^{++}, Co^{++}, and Mn^{++} are preferentially chelated over Ca^{++} (*9*) and thus remain chelated, even in an excess of Ca^{++}.

The action of EDTA in protecting mice from the toxin is undoubtedly due to its ability to chelate metal ions, inasmuch as it no longer protects when an "essential" ion is present in excess. The protection afforded by EDTA and the reversal of this protection by an "essential" ion are rather dramatic. The mice that received the toxin plus EDTA manifested no ill effects and no decrease in their normal activity. In those mice in which the protective action of EDTA was reversed by either Zn^{++}, Co^{++}, or Mn^{++}, the pattern of death was identical with that of the controls that received toxin alone. They all died in the same time interval, and had an extensive area of inflammation at the site of injection.

The action of the toxin is not confined to the injection site. Therefore the EDTA exerts more than a local effect. An experiment was performed in which the toxin and EDTA were injected into different sites on opposite sides of mice, and five of the ten mice survived. The greater amount of protection that resulted when the toxin and EDTA were injected simultaneously indicates that inhibition of the toxin at the site of injection is involved in this enhanced protection. A study of the dosage levels of EDTA and Ca-EDTA that are required to protect animals when they are given by intravenous and other routes has been started.

EDTA is not toxic for animals and human beings until an amount is given that induces a hypocalcemic state with resultant tetany (*10*), but Ca-EDTA can be given in large quantities without any apparent toxicity and has been used clinically in cases of lead poisoning (*11*). The possible use of Ca-EDTA in the therapy of gaseous gangrene is obvious.

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References and Notes

1. M. G. McFarlane and B. C. J. G. Knight, *Biochem. J. London* 35, 884 (1941).
2. M. G. McFarlane, in *Mechanisms of Microbial Pathogenicity* (Cambridge Univ., London, 1955).
3. E. A. Meyer and M. Moskowitz, *J. Bacteriol.* 69, 111 (1955).
4. Used as Di-Sodium Di-Hydrogen Versenate (analytic reagent). Kindly supplied by the Bersworth Chemical Company and their successor, the Dow Chemical Company.
5. Supported in part by a grant from the Purdue Research Foundation and grant G-3444 of the National Institutes of Health, U.S. Public Health Service.
6. Kindly supplied by Lederle Laboratories Division, American Cyanamid Company.
7. Borate-buffer was made up as follows: (i) 1.25 g of boric acid was dissolved in 100 ml of 0.16*M* NaCl, and (ii) 1.9 g of Borax was dissolved in 100 ml of 0.16*M* NaCl; 10 ml of ii mixed with 90 ml of i to give a *p*H of 7.6. The final *p*H of the mixtures used for injection was 6.9 to 7.1.
8. P. C. Zamecnik, L. E. Brewster, F. Lipmann, *J. Exptl. Med.* 85, 381 (1947).
9. *The Versenes* (Bersworth Chemical Co., Framingham, Mass., 1953).
10. A. Popovici *et al.*, *Proc. Soc. Exptl. Biol. Med.* 74, 415 (1950).
11. H. L. Hardy *et al.*, *J. Am. Med. Assoc.* 154, 1171 (1954).

19 December 1955

Simplotite, New Calcium Tetravanadite from the Colorado Plateau

Simplotite, $CaV_4O_9 \cdot 5H_2O$, is a new mineral found in several vanadium-uranium mines on the Colorado Plateau (*1*). The mines are located in the Salt Wash sandstone member of the Morrison formation of late Jurassic age. The new mineral is named in honor of J. R. Simplot (*2*), former owner of the Peanut Mine, Montrose County, Colo., where the material used for this description was collected.

Simplotite occurs as hemispherical aggregates of dark-green, platy crystals. It is found in comparatively unoxidized ore and is associated with montroseite, paramontroseite, vanadiferous silicates, uraninite, and coffinite. At the Peanut Mine it occurs as coatings on fractures in the ore-bearing sandstone with duttonite, $VO(OH)_2$ (*3*), melanovanadite, native selenium, and an undescribed vanadium oxide.

The color of simplotite varies from nearly black, in coarse aggregates, to yellow-green, in thin flakes. It is biaxial negative; 2V is about 25°; and dispersion is $r > v$, weak and crossed. X = *b* (yellow); Y (green); Z $\wedge$ *c* = +58° (green); $\alpha = 1.705 \pm 0.002$, $\beta = 1.767 \pm 0.002$, $\gamma = 1.769 \pm 0.002$. The specific gravity, as measured by immersion in a mixture of bromoform and acetone, is 2.64 ± 0.02.

A microchemical analysis made by one of us (R. M.) on approximately 70 mg of simplotite showed the following composition: CaO, 11.6 percent; V_2O_4, 67.7 percent; V_2O_5, 0.5 percent; H_2O, 18.4 percent; and insoluble material, 0.5 percent; total, 98.7 percent. Qualitative spectrographic analysis by Katherine E. Valentine of the original material indicated the presence of Mg and Al in amounts of 0.1 to 0.5 percent and Na, K, and Fe in amounts 0.05 to 0.1 percent.

Simplotite is monoclinic and pseudotetragonal. It has a very easy micaceous cleavage on (010) and is very soft. The unit-cell constants were determined by M. E. Mrose of the U.S. Geological Survey as follows: $a_0 = 8.39 \pm 0.02$ A, $b_0 = 17.02 \pm 0.02$ A, $c_0 = 8.37 \pm 0.02$ A, $\beta = 90°25' \pm 5'$; $a:b:c = 0.4929:1:0.4918$. The space group is C $2/m$; the cell contents are 4 $(CaV_4O_9 \cdot 5H_2O)$; and the calculated specific gravity is 2.65.

Simplotite was first found in 1952 by Alice D. Weeks and other members of the U.S. Geological Survey field party at the Sundown claim, San Miguel County, Colo. The sample used for this description was collected by one of us (C. H. R.) in the course of a detailed study of the mineralogy, geochemistry, and geology of the Peanut Mine. The mineral has been identified in the following three other mines: the Shattuck-Denn lease on Club Mesa and the J. J. Mine in Paradox Valley, both in Montrose County, Colo., and the Vanadium Queen Mine at La Sal Creek, San Juan County, Utah.

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References and Notes

1. Publication authorized by the director, U.S. Geological Survey. The study of the mineralogy of the uranium deposits of the Colorado Plateau is part of a program being conducted by the U.S. Geological Survey on behalf of the Division of Raw Materials of the U.S. Atomic Energy Commission.
2. J. R. Simplot Mining Co., Boise, Idaho.
3. M. E. Thompson, C. H. Roach, R. Meyrowitz, *Science* 123, 990 (1956).

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16 January 1956

Relation of Aromatic Amino Acids to Excretory Pattern of Schizophrenics

It has been shown that schizophrenics generally excrete a number of aromatic compounds that appear little, if at all, in normal urine (*1, 2*). The appearance of these abnormal metabolites may be related to the production in schizophrenia of some hallucinogen. Because of the well-known limitations on human biosynthesis of aromatic compounds, such abnormal metabolites are most probably derived from the dietary aromatic amino acids, phenylalanine, tyrosine, and tryptophan. Limiting the dietary intake of one or all of these aromatic amino acids should provide evidence concerning the origin of these aromatic compounds. With this in mind, we fed a

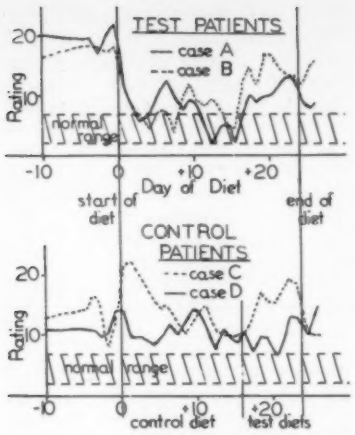

Fig. 1. Two-day running average of chromatographic ratings. Case C received a diet low in tryptophan from the 16th to the 24th day; case D received a diet low in phenylalanine and tyrosine during the same period.

diet low in the aromatic amino acids to a small group of schizophrenic volunteers (*3*). Biochemical changes were followed by the chromatographic method previously reported (*2*).

Four male chronic schizophrenics were kept under close supervision in an isolated ward for the period of the diet, as well as for a month preceding. In order to reduce protein reserves that might furnish aromatic precursors, we gave the patients a low-protein diet (40 g/day) for 1 week before the experimental period. Two patients, A and B, were then placed for 24 days on a test diet that lacked all three aromatic amino acids. This test diet was similar to those used in studies on the essential character of tryptophan and for the treatment of phenylketonuria (*4*). Patients C and D, who served as controls, were fed a control diet for 16 days; this control diet appeared exactly the same as the test diet, but it contained all the essential amino acids. For the remaining 8 days, case C was given the test diet with added phenylalanine and tyrosine (lacking only tryptophan), while case D was given the test diet with added tryptophan (lacking phenylalanine and tyrosine). Estimated daily intakes of the aromatic amino acids and of histidine are indicated in Table 1.

A concentrated (10:1, in a vacuum) sample of the daily morning urine of each patient was analyzed chromatographically for diazo-coupling compounds according to the method previously described (*2*); these chromatograms were compared with chromatograms of normal urine prepared under identical conditions. Each chromatogram was rated according to the number and intensity of spots. The results, which are plotted in Fig. 1, can be summarized, as follows:

1) The chromatograms of the urine of schizophrenic patients (pre-diet) generally showed a greater than normal number and intensity of spots.

2) The chromatograms of the urine of patients on the test diet, which was lacking in phenylalanine, tyrosine, and tryptophan, showed a reduction in the number and intensity of spots to normal or near-normal range.

3) The chromatograms of the urine of patients on the control diet, which contained all the aromatic amino acids, showed no such decrease in color.

4) The color in the chromatograms of patients on the test diet dropped sharply at first, but, after about 16 days, some color began to reappear. It is not known why this occurred, but it may be significant that the patients' nitrogen excretion dropped at the same time.

5) The results with patients whose diet was lacking only tryptophan (case C) or only phenylalanine and tyrosine (case D) allow no definite conclusions regarding the origin of the chromogens, but they suggest that the greater part of the color is derived from phenylalanine and tyrosine metabolites.

The chromatograms were analyzed for the frequency of occurrence of each spot during the various test periods (Table 1). In general, the spot-by-spot analysis confirmed the findings listed here. Of the 13 colored areas particularized, nine appear much more frequently in the urine of schizophrenics than in the urine of normal individuals; two may not appear at all in normal chromatograms. All but one of the "abnormal" spots showed a significant decrease in frequency during the period of test diet.

The patients showed little or no physical change during the experiment. There was no significant variation in weight or blood nonprotein nitrogen. The patients were kept under psychiatric observation and given electroencephalograms before, during, and after the test period. Minor changes were noted in patients A, B, and C, but these were not considered to be significant; no change was noted in patient D. It is felt that the lack of significant clinical change during the brief span of this experiment does not influence the hypothesis that schizophrenic hallucinations may be of biochemical origin. The patients were all chronic cases with well-established abnormal behavior patterns. The refrac-

Table 1. Spot-by-spot analysis of chromatograms and estimated daily intake of aromatic amino acids. The effect of the various dietary regimens on the aromatic excretion pattern may be obtained from comparison of the figures given in the various columns; changes of less than 10 percent should not be considered significant.

Color and R_f*	Frequency of occurrence (%)						
		Test patients		Control patients			
		Cases A + B		Cases C + D		Case C	Case D
	Normals (18 cases)	Pre-diet (10 days)	Test diet (24 days)	Pre-diet (10 days)	Control diet (16 days)	Test diet + tyrosine and phenylalanine (8 days)	Test diet + tryptophan (8 days)
Brown to yellow (R_f 0–0.1)	80	93	42	77	47	87	75
Brown (R_f 0.1–0.2)	40	93	15	57	33	66	25
Yellow (R_f 0.1–0.2)	20	64	34	28	31	71	42
Yellow or orange (R_f 0.2–0.3)	20	86	44	71	60	87	87
Yellow to brown (R_f 0.3–0.35)	0	67	25	40	37	55	30
Red or pink-brown (R_f 0.3–0.4)	10	79	27	72	91	90	40
Yellow to brown (R_f 0.38–0.45)	15	86	40	70	57	75	66
Yellow (R_f 0.55–0.6)	80	98	62	74	46	75	71
Pink (R_f 0.56–0.66)	80	100	43	89	61	86	43
Yellow-brown (R_f 0.62–0.72)	0	50	9	53	50	50	25
Orange (R_f 0.72–0.78)	92	97	89	75	67	72	7
Red to brown (R_f 0.85)	20	87	28	41	65	12	63
Yellow (R_f 0.85–0.9)	20	80	83	100	62	78	20
Estimated daily intake in grams							
Histidine		1.1	1.8	1.1	1.8	1.8	1.8
Phenylalanine		2.4	< 0.2	2.4	7.0	5.0	0.2
Tyrosine		1.9	< 0.2	1.9	5.6	4.0	0.2
Tryptophan		0.7	< 0.1	0.7	2	0.1	5.5

* Reduced to an R_f of 0.5 for the urea spot.

toriness of chronic schizophrenia to treatment with Frenquel and reserpine (*5*) suggests that changes may take place which are not readily reversed.

The chromatographic work does point to a physiological alteration in schizophrenia which can be controlled by means of a suitable diet. It remains for future work to establish whether such an alteration is of basic importance to the disease.

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References and Notes

1. M. K. Young, Jr., *et al., Univ. of Texas Publ. No. 5109* (1951), pp. 189–197; I. Sano, *Folia Psychiat. et Neurol. Japonica* **8**, 218 (1954).
2. P. L. McGeer, E. G. McGeer, W. C. Gibson, *Science* **123**, 1029 (1956).
3. We wish to thank the laboratory and dietetic staff of the Provincial Mental Hospital and of Crease Clinic; without their cooperation this project would have been impossible.
4. L. I. Woolf *et al., Brit. Med. J.* 1955I, 57 (1955); L. E. Holt, Jr., *et al., Proc. Soc. Exptl. Biol. Med.* **48**, 726 (1941).
5. F. Rinaldi *et al.*, paper presented before the American Psychiatric Association, Atlantic City, May 1955.

20 December 1955

Induced Spawning in the Indian Catfish

In the course of an investigation of the relationship between structural changes in the pituitary and the development of ova in the common Indian catfish, *Heteropneustes* (*Saccobranchus*) *fossilis* (Bloch), we have attempted to induce spawning under laboratory conditions (*1*). This work is preliminary to a wider project designed to bring about the spawning of other major Indian carps (*Labeo, Cirrhina, Catla*) in confining waters. Thus restricted, either these species may become gravid but fail to ovulate, or they may discharge unfertilized eggs (*2*). So far as we are aware, no attempt has previously been made in India to induce spawning of food fishes by injecting fresh (or acetone dry) pituitaries of the same species. Injections of mammalian pituitary preparations result in ova that are not viable (*3*).

Heteropneustes breeds in large tanks just after the monsoon showers. Ghosh and Kar (*4*) report that the active phase of the ovary extends from late April to July, but we have collected gravid females in August and September (1955). These were taken from a local tank (Bellandur, area 893 acres) from which all of our supply comes. The occurrence of gravid fish in our collections after the normal breeding season is doubtless due to the delay in the break of the monsoon. Weights of the gravid fish ranged from 70 to 135 g. They were held in aquaria (60 by 30 by 33 cm) that were supplied with city water from overhead cisterns, and the water was renewed daily. No additional aeration was provided, and all experiments were conducted at room temperature (24° to 25°C). The animals were not fed during the experimental period.

After a series of replications, it was found that a single injection of one-quarter of a fresh pituitary from a gravid *Heteropneustes* homogenized in 0.5 ml of standard Holtfreter solution was quite effective.

The injections were administered intramuscularly, since it was difficult to give intraperitoneal injections without damaging the egg-laden ovisacs. Controls injected with an equal quantity of Holtfreter solution did not spawn. Only specimens weighing more than 80 g were utilized, since it was found that smaller animals did not always respond to the injections.

Because spawning usually happened during the night, we have not been able to compute the time lapse necessary for the gravid females to spawn after each injection. However, our experiments indicate that at least 12 to 14 hours must elapse before the injected females spawn in aquaria. Eggs stripped from such females the following morning were fertilized in sperm suspension in Holtfreter solution and were cultivated both in Holtfreter solution and city water, since spring water was not easily accessible to us. Development proceeded normally in both media, and hatching took place within 32 to 34 hours.

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References and Notes

1. We wish to express our thanks to B. R. Seshachar, Central College, for kind encouragement.
2. S. L. Hora, *Proc. Nat. Inst. Sci. India* **11**, 303 (1945).
3. A. Husain, *ibid.* **11**, 320 (1945).
4. A. Ghosh and A. B. Kar, *Proc. zool. Soc. Beng.* **5**, 29 (1952).
* Research scholarship, Ministry of Education, Government of India.

28 December 1955

Postirradiation Protection of Rabbits by Injection of "Splenic" Plasma

Jacobson (*1*) has attributed the "protection" of animals by shielding of the spleen during irradiation to a "humoral factor" elaborated by the spleen. It has also been shown that injection of certain tissue homogenates (of spleen or bone marrow, for example) soon after irradiation is similarly protective. However, it seems that the presence of cells or cell fragments in the injected material is necessary to bring about protection. If the postulated humoral factor is elaborated by the spleen, it should be present in higher concentration in the blood leaving the spleen. Therefore, plasma of blood taken from the splenic vein should exhibit a protective action.

Table 1. Comparative data in series I and II.

No. of animals	Plasma injection* (cm^3)	30-Day survival (%)	Avg. survival (day)
First series			
27		22	14.4
13	6 A	54	22.2
10	6	20	16.0
15	3†	20	14.4
Second series			
25		4	8.9
25	6 A	24	14.4
25	6 B	18	12.2

* Intraperitoneal, except where otherwise indicated.
† Intravenous. Eight rabbits received A plasma and one B plasma. The other six had been injected before it was thought necessary to distinguish between A and B plasma.

Such an experiment has been carried out using adult male chinchilla rabbits (*2*). In essence, heparinized blood was obtained from a nonirradiated donor rabbit as follows. The distal gastric coronary vein and artery were ligated at the stomach wall and then severed beyond the ligature on the spleen side. Blood from the splenic vein and artery was allowed to flow into a test tube in ice water through a polyethylene tube. This "splenic blood" is really a mixture of blood from the splenic vein, the splenic artery, and the proximal gastric coronary veins. The first 35 cm^3 of blood thus collected constitutes the A sample and the second 35 cm^3 the B sample. Each sample was centrifuged for 20 minutes at 2300 rev/min, and the plasma was separated.

After centrifugation of the splenic blood, approximately 18.0 cm^3 of plasma was carefully removed by pipette for injections. After the three 6.0-cm^3 doses of plasma had been injected, a residual drop of the plasma was placed on a slide, covered with a cover slip, and examined microscopically. No cells were found in the specimens examined. In one case, a more significant search for cells in splenic plasma was made as follows. Measured amounts of the plasma were drawn into erythrocyte- and leukocyte-diluting pipettes, and then the plasma

was examined on a standard blood-counting chamber. In addition, three slides were smeared with plasma, fixed with heat, and stained respectively with Wright's blood stain, methylene blue, and bromphenol blue. No cells could be found. While the possibility of the presence of some cells or cell fragments in the plasma cannot be ruled out categorically, it seems reasonable to assume that it was cell-free.

All rabbits were given, in about 10 minutes, a whole-body dose of x-rays of 1000 r measured in air at the center of the body (210 kv constant potential, 1 mm Cu half-value layer). The animal was irradiated in a lucite box 12 in. by 6 in., with the center of the body 50 cm directly below the x-ray-tube target. The plasma was injected as soon as practicable after the irradiation. In the exploratory part of the experiment, plasma was injected intravenously in some animals and intraperitoneally in others. Since intravenous injections seemed to be ineffective, they were not used in the second series. It is important to note that the rabbits were obtained in small groups as nearly identical in age and weight as possible and that a control animal in each group received x-rays only. In many cases, the animals were litter mates. The results are shown in Table 1.

Statistical analysis of the first series of 68 rabbits shows that intraperitoneal injection of A plasma gave a statistically significant (at the 0.05 level) increase in number of days surviving as compared with the controls and also as compared with the control and B-plasma animals combined. The effect of B plasma was not statistically significant. In the second series of 75 rabbits, A plasma gave a statistically significant (at the 0.01 level) increase in number of days surviving as compared with controls. All plasma A and B animals, taken together, showed a significant (at the 0.05 level) increase in number of days surviving as compared with the controls.

Thus, the protective action of freshly drawn cell-free splenic plasma (sample A) injected intraperitoneally into chinchilla rabbits soon after exposure to 1000 r of x-rays is very definite. The protective action of B plasma is questionable but perhaps not zero. This indicates a greater concentration of some protective agent discharged into the splenic blood during the first part of the bleeding period. It is of interest to note in this connection that, after 10 to 25 cm^3 of blood has been collected, the spleen collapses and remains quite flat thereafter.

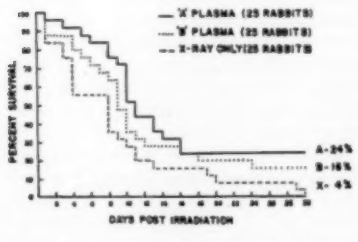

Fig. 1. Percentage survival of rabbits used in second series during 30-day test period.

It will be noted that the x-ray effect was greater in the second series than in the first, although the experimental procedure was the same. However, the rabbits of the first series were housed outdoors (mild weather) in the Loch Awe Rabbitry, from which all the animals were obtained, whereas those of the second series were kept in the animal care facilities of the College of Physicians and Surgeons, Columbia University. The survival curves of the 75 animals used in this series are given in Fig. 1.

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References and Notes

1. L. O. Jacobson, *Cancer Research* 12, 315 (1952).

2. This article is based on work performed under contract AT-30-1-Gen-70 for the U.S. Atomic Energy Commission. A description of the experimental procedure is in preparation. We wish to thank A. E. Brandt, New York Operations Office, U.S. Atomic Energy Commission, for the statistical analysis and for helpful suggestions in the course of this work. We also wish to thank G. Failla, Columbia University, for his interest and guidance.

27 January 1956

Effect of Polarized Light on Polarity of Fucus

In 1941 Child (*1*) noted that, when *Fucus furcatus* zygotes were exposed to unilateral light the direction of which was reversed at hourly intervals, there arose an unspecified percentage of bipolar embryos, forms with rhizoids originating at opposite poles. I have confirmed and widely extended Child's report. In particular, it was observed that bipolar forms were effected just as frequently by oppositely directed light beams when they acted simultaneously as when they acted alternately. It was also noted that the rhizoids of the bipolar forms tended to develop perpendicularly to the light beams. However, the orientation and position of the bipolar forms in the culture vessels suggested that polarization of the light by reflection might have played a determining role.

Accordingly, I investigated the results of exposing *F. furcatus* eggs to two vertical beams of deliberately polarized light, one coming from a lamp above and the other from a mirror below the eggs. Recently fertilized eggs were thoroughly washed with and cultured in artificial sea water (*2*) at 11°C in four glass petri dishes at concentrations of approximately 2 eggs/mm^2. One of these was cultured in the dark and three were cultured in light for 22 hours (starting at 2 hours after fertilization) and subsequently in the dark. The light source was a General Electric standard, cool, white, 20-w fluorescent lamp placed above the culture dishes. In each case, the light was collimated into a beam that was directed downward and held within ±3.1° of the vertical, and that was of an intensity of about 1 ft-ca. In two cases, the beam was then filtered through a Polaroid laboratory J-filter placed just above the culture vessel. In the third case, the beam entered the dish directly. A back-surface-silvered mirror was placed just below each illuminated dish, thus reflecting upward into each a second beam of ap-

Fig. 1. Four-day-old embryos of *F. furcatus* cultured in the dark (top); in nonpolarized white light (middle); in plane polarized light (bottom). (×4).

proximately 80 percent the intensity of that coming from above.

The filters in the two duplicate experiments were placed with their planes of polarization perpendicular to each other to unmask any unforeseen influences, such as light reflected within, or leaking into, the experimental box.

When the test cultures that were illuminated with polarized light were inspected 3 days after fertilization, one saw not only a profusion of bipolar forms, but also a striking tendency of the rhizoids to develop horizontally and in the plane of vibration (PP, Fig. 1) of the electric vector. A portion of a shadowgraph of one of the test cultures is shown in the bottom section of Fig. 1. Portions of shadowgraphs of the controls are shown in the top and middle sections of Fig. 1.

A quantitative measurement was then made of the orientation with respect to PP of all the 171 rhizoids developed by 124 embryos that were selected as a representative sample of the two test cultures. The distribution of the angles between these rhizoids and PP showed a single sharp maximum at 0°. Of these 171 rhizoids, 118, or 69 percent, lay within 10° of PP; 167, or 98 percent, within 45° of PP; and none between 80° and 90° of PP. (In a randomly oriented population, 11 percent would lie within 10° of PP, 50 percent within 45°, and 11 percent between 80° and 90°.)

This experiment, in which two cultures were exposed to polarized light, one to unpolarized light, and one to no light, was twice repeated. It was apparent upon inspection that the rhizoids in the two confirmatory experiments showed the same marked tendency to develop in the plane of polarization.

The percentage of bipolar forms was measured in all the cultures. In the six exposed to polarized light, between 27 and 53 percent of the embryos were bipolar; in the three exposed to unpolarized light, between 4 and 12 percent were bipolar; in the three exposed to no light, between 1.3 and 3.2 percent were bipolar.

It would be premature to discuss the relative roles of the light's intensity, spatial pattern, and polarization in effecting the development of these bipolar forms. Nevertheless, the fact that up to 50 percent of these bipolar forms can be produced by some type of temporally constant illumination strongly implies that the polarity of the *Fucus* egg arises epigenetically rather than being determined by the rotation of a preformed asymmetric structure such as the nucleus. These phenomena are being investigated further.

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References and Notes

1. C. M. Child, *Patterns and Problems of Development* (Univ. of Chicago, 1941), p. 423.
2. Prepared from reagent-grade salts of Na^+, K^+, Ca^{++}, Mg^{++}, Cl^-, SO_4^{--}, and HCO_3^- dissolved in glass-distilled water in proportions taken from H. U. Sverdrup *et al.*, *The Oceans* (Prentice-Hall, New York, 1942), Table 35, p. 173.
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13 January 1956

Catheptic Activity in Tissues of Tumor-Bearing Rats

If cathepsins play a catabolic role *in vivo*, one might expect in tumor-bearing animals an elevated cathepsin concentration in such tissues as muscle which are undergoing proteolysis, while no increases would be expected in tissues that are enlarging (liver, spleen, and tumor). On the contrary, catheptic activity was found to be increased in the livers of many cancerous rats (*1*). However, these cathepsin assays were conducted at the customary but nonphysiological *p*H of 3.5. In the present study (*2*), cathepsin concentrations of several tissues in normal rats and in rats bearing Walker-carcinoma-256 implants have been measured at both *p*H 3.5 and 7.5.

The cathepsin assay technique employed was essentially the Snoke-and-Neurath (*3*) modification of Anson's (*4*) method. The tissues were homogenized in a glass homogenizer with 5 volumes of 2 percent potassium chloride. (Minced muscle was dispersed in a Waring blendor.) After centrifugation, 2 ml of the resulting extract was added to 5 ml of substrate. The hemoglobin substrates at *p*H 3.5 and 7.5 were Anson's (*4*) substrates for cathepsin and trypsin, respectively. Two-milliliter samples of the digestion mixture were pipetted into 5 ml of 5-percent trichloroacetic acid at 0 and 20 minutes. After the samples had been centrifuged the difference in optical density at 280 mμ of the supernatant solutions of the 0- and 20-minute samples was used as the measure of proteolysis.

Table 1. Cathepsin concentrations of various tissues of normal and tumor-bearing rats. Concentrations are in Anson's cathepsin units $\times 10^3$ per gram of tissue. There were six rats in each group.

Tissue	Assayed at *p*H 3.5		Assayed at *p*H 7.5	
	Normal	Tumor	Normal	Tumor
Liver	0.74	0.89	1.32	1.30
Kidney	0.80	1.36	1.28	1.31
Spleen	2.21	1.78	2.80	1.85
Muscle	0.23	0.26	0.24	0.27
Tumor		0.75		0.76

Table 1 shows the average cathepsin concentrations of several tissues of normal and tumor-bearing rats. The values found at *p*H 3.5 for liver, kidney, and spleen were similar to those of Maver, Dunn, and Greco (*1*) with the exception of an increase in kidney cathepsin in the tumor-bearing rats. Muscle cathepsin of the tumor-bearing rats did not reflect the rapid proteolysis that, presumably, was occurring in this tissue. Surprisingly, the cathepsin levels at *p*H 7.5 were fully as high as those obtained at *p*H 3.5 At this *p*H, there were no differences between the two groups of rats. The cathepsin level in the tumors was found to be intermediate. Recently, catheptic activity was found to increase markedly in spontaneously regressing Flexner-Jobling carcinomas (*5*). This evidence would favor a catabolic role for cathepsins *in vivo*.

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References and Notes

1. M. E. Maver, T. B. Dunn, A. Greco, *J. Natl. Cancer Inst.* 9, 39 (1948).
2. This work was aided by grants from the American Cancer Society and its Iowa Division.
3. J. E. Snoke and H. Neurath, *J. Biol. Chem.* 187, 127 (1950).
4. M. L. Anson, *J. Gen. Physiol.* 22, 79 (1938).
5. P. H. Fodor, C. Funk, P. Tomashefsky, *Arch. Biochem. and Biophys.* 56, 281 (1955).
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13 January 1956

Rate of Postglacial Rise of Sea Level

The results of careful studies of peat and shell material from Velsen in North Holland reported by van Straaten (*1*), and radiocarbon measurements on this material by deVries and Barendsen (*2*) have led to a fairly adequate knowledge of the approximate sea stand as a function of time for the Dutch coast over the past 8000 years. These authors represent their results by a figure showing radiocarbon age of shell and peat versus depth of the sample horizon relative to the present strand line. The same is shown in this report (*3*) in Fig. 1; we have added measurements from other localities for comparison. Most of the added measurements were made by the Magnolia Petroleum Laboratory, Houston, Tex., on material that was obtained from bays, barrier islands, and the continental shelf of the Texas and Louisiana coasts (*4*). The sources of other dates are indicated in the figure caption.

With the exception of several dates that were determined by the Lamont Geological Observatory, the measurements appear to show approximately equal rates in the rise of the sea level at

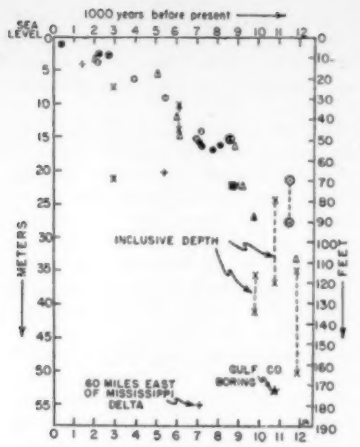

Fig. 1. Radiocarbon ages relative to depths below present sea level. Samples of wood and shells are believed to have been deposited essentially at sea level. No correction has been made for compaction or subsidence from other causes. ■, wood (Suess, U.S. Geological Survey, Australia, 9); ○, shells, and ●, peat (deVries and Barendsen, Holland); △, shells, and ▲, wood (Magnolia Petroleum Laboratory, Texas Gulf); +, shells, and ×, wood (Kulp, Lamont Geological Observatory, Mississippi Delta); ⊙, wood (Kulp, Bermuda); ✱, shells (Humble Oil Company, Texas Shelf).

the various localities. This may indicate that the observations reflect the actual eustatic change that accompanied the melting of the last ice sheets rather than the effects of local tectonic movements or compaction. It is obvious, however, that many more measurements from a variety of locations must be made before it will be possible to distinguish conclusively between eustatism, tectonic movements, and compaction.

A possible temporary halt in the rise of the sea level some 7000 or 8000 years ago seems to be indicated by samples from both North Holland and the Gulf Coast. Such a halt may conceivably correspond to the Cochrane halt in the retreat of the ice (*5*).

The picture becomes confused prior to the last 10,000 years, which may be due to imperfection of the data, or, possibly, to an oscillation of the sea stand connected with the Mankato readvance of the ice sheets around the Great Lakes (*6*). Evidence for or against changes in the rate of eustatic rise in correlation with oscillations of the ice sheets might prove helpful in determining whether or not glacial readvances were synchronous on different continents and in the two hemispheres.

Perhaps the most interesting question connected with these observations is that of the supposed postglacial higher sea stand during the "climatic optimum" (*7*). Neither the samples from the Gulf Coast nor those from North Holland give any indication of a postglacial sea level higher than that of the present. As yet no evidence from carbon-14 measurements has been produced that would prove such a high sea level, and a sample (W-185) of shells from one of the low terraces from Western Australia (+10 to 12 ft), which was expected to date this sea stand, gave an age of more than 30,000 years.

Any assistance in securing samples for radiocarbon determinations that would date a sea level as accurately and as conclusively as possible and hence give a bearing on the afore-mentioned problems would be greatly appreciated.

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References

1. L. M. J. U. van Straaten, *Geol. en Mijnbouw* 16, 247 (1954).
2. H. L. deVries and G. W. Barendsen, *Nature* 174, 1138 (1954).
3. Contribution from the Scripps Institution of Oceanography, new series, No. 856. This investigation was supported in part by a grant from the American Petroleum Institute, project 51, and by a contract between the Office of Naval Research and the University of California.
4. F. P. Shepard and D. G. Moore, *Bull. Am. Assoc. Petroleum Geol.* 39, 1463 (1955).
5. H. E. Suess, *Science* 123, 355 (1956).
6. L. Horberg, *J. Geol.* 63, 278 (1955); R. F. Flint and M. Rubin, *Science* 121, 649 (1955).
7. Plant fossils indicate that during a short period about 5000 years ago the climate may have been warmer than it is now. See R. F. Flint, *Glacial Geology and the Pleistocene Epoch* (Wiley, New York, 1947), pp. 187–191.
8. H. N. Fisk and E. McFarlan, Jr., *Geol. Soc. Amer. Spec. Paper* No. 62 (1955), pp. 279–302; J. L. Kulp, *Sci. Monthly* 75, 5 (1952).
9. H. E. Suess, *Science* 120, 467 (1954).

21 December 1955

Lactose in the Sapotaceae

Lactose has been reported (*1*) to occur in the tropical fruit *Achras sapota*, but the supporting evidence is minimal. In order to confirm this report, a preliminary investigation (*2*) has been made in this laboratory on the fruits of the aforementioned species as well as on the related species *Mimusops roxburghiana* and *Ponteria campechiana* (*3*).

Samples of 30 to 40 g (wet weight) of the fresh fruit were extracted with 50-percent ethanol until extraction of sugar was complete. The total amount of sugar present was determined as glucose by the anthrone method (*4*). The bulk of the sugar present (glucose) was removed by fermentation with washed *Saccharomyces cerevisiae*. Extracts of all three fruits, when examined chromatographically (butanol, pyridine, and water, 6 to 4 to 3), showed evidence of a compound having the same R_f as a lactose standard. In order to remove interfering compounds, the extracts were adsorbed on charcoal-celite columns (*5*), which were then washed with water to remove salts and monosaccharides. Lactose and small amounts of higher sugars were eluted with 50-percent ethanol.

Table 1. Lactose content of fruit of *Achras sapota*, *Ponteria campechiana*, and *Mimusops roxburghiana*.

Plant	Dry wt. (% of wet wt.)	Total sugar (% of dry wt.)	Lactose (% of total sugar)
A. sapota	25	74	0.023
P. campechiana	33	69	0.043
M. roxburghiana	41	38	0.028

In order to confirm the presence of lactose qualitatively and to effect a quantitative estimation, we employed a purified preparation of *Escherichia coli* beta-galactosidase (*6*). This enzyme was devoid of alpha-glycosidase activity. The glucose that was split from the lactose by enzyme action was estimated spectrophotometrically with a Beckmann model DU instrument. Into a silica cuvette was pipetted 0.8 ml of buffer [0.1*M* tris(hydroxymethyl)aminomethane at *p*H 7.2 and $10^{-3}M$ $MgCl_2$], 30 μlit of Zwischenferment (5 mg/ml), 20 μlit of TPN (8 mg/ml), 10 μlit of ATP (50 mg/ml), and 50 to 100 μlit of the sample. At this stage, any trace of glucose in the sample was detected by the increase in optical density at 340 mμ. The beta-galactosidase was then added (20 μlit) by micropipette, and the changes in optical density were followed until the rate became negligible. In this procedure, 36 μg of lactose caused a rise in density of 0.560 in 15 minutes. The theoretical value of 0.620 could be obtained by using more enzyme and a longer observation time. Only a sugar containing glucose bound in a beta-glycosidic linkage will be assayed by this procedure.

It is evident (Table 1) that lactose is present only in small quantity but is readily determinable. About 10 to 20 mg would be present in a whole ripe fruit. It is our intention to examine fruits of other members of the Sapotaceae and to inquire into the mode of lactose formation in them.

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References and Notes

1. R. Ulrich, *La Vie des Fruits* (Masson, Paris, 1952).
2. This work was performed under contract No. AT(45-1)-507 between the U.S. Atomic Energy Commission and the University of Oregon.
3. These fruits were obtained through the good offices of the Agricultural Experiment Station,

Paramaribo, Surinam, and the Sub-Tropical Experiment Station, Homestead, Fla.
4. J. Kahan, *Arch. Biochem and Biophys.* 47, 408 (1953).
5. R. L. Whistler and D. F. Durso, *J. Am. Chem. Soc.* 72, 677 (1950).
6. Kindly supplied by Melvin Cohn, Washington University, St. Louis, Mo.

9 January 1956

Effect of Growth Hormone and Acromegaly on Plasma Phospholipid

We have used the technique of labeling with radiophosphorus to study the effect of administered anterior pituitary growth hormone and of acromegaly on plasma phospholipid. In both cases there is a lowering of the rate of plasma phospholipid formation, if "formation" is defined as the sum of metabolic processes and membrane transfers involved in the entry of newly-formed phospholipid into the blood.

Although it appears that plasma phospholipids are made and destroyed in the liver, these processes are independent of severe liver injury. Experiments in man, by Cornatzer and Cayer (*1*), have demonstrated a constant rate of phospholipid formation in any individual in spite of time and change in liver function. Among individuals, however, they found a wide normal variation. Zilversmit's (*2*) experiments with adrenalectomized dogs have focused attention on endocrine control of the liver-plasma phospholipid system.

In our experiments, 100 to 400 μc of labeled inorganic phosphate were given intravenously, and plasma samples were drawn at 15, 24, 40, and 60 hours. The plasma was extracted with trichloroacetic acid (TCA), and the relative specific activity of phosphorus in both the TCA-soluble fraction and phospholipid fraction was determined. These values were plotted against time; both the curves obtained and the average value of stable phospholipid phosphorus were considered. When the effect of growth hormone was studied, each patient acted as his own control, with pretreatment and treatment curves being determined at an interval of 1 week. Studies were also made on a series of acromegalic patients to show the effect of excess endogenous growth hormone.

Figure 1*A* shows composite curves from six endocrinologically normal patients, each of whom had two series of determinations with no intervening

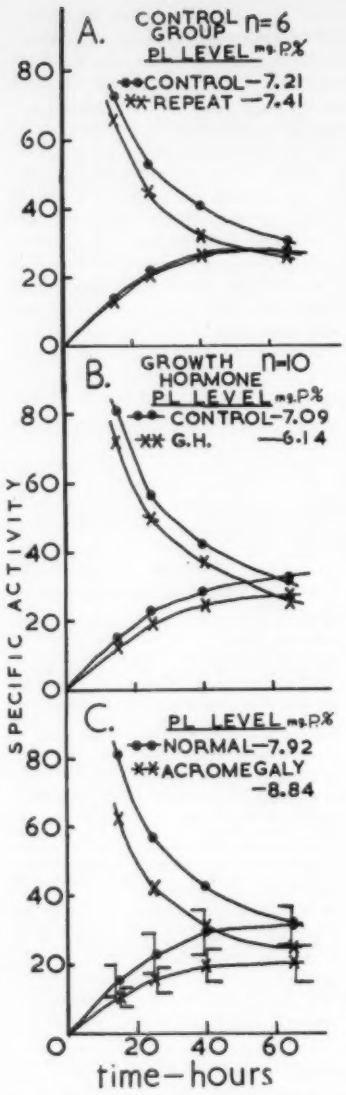

Fig. 1. The specific activity is expressed as a ratio of the percentage of the dose in counts per minute $\times 10^{-4}$ divided by milligrams of phosphorus.

treatment. The rising curves show specific activity of the phospholipid fraction; the falling curves show that of the TCA-soluble fraction. In each case the two phospholipid curves were identical. This confirms the constancy of the curve and the validity of repeating the test after such a short interval. The figure also shows that the TCA-soluble and phospholipid curves intersect at their peaks, giving a Zilversmit product-precursor relationship. There is no significant change in the total phospholipid-phosphorus values.

The effect of the intramuscular administration of growth hormone is shown in Fig. 1*B*. Ten patients received 100 mg daily in four divided doses. The treatment curve is flatter than the control curve, and the plasma-phospholipid phosphorus is significantly decreased. These changes, both of curve and level, were constant in direction in each patient studied and indicate a decrease in the rate of plasma-phospholipid formation. This decrease was the only metabolic effect of growth hormone observed. There was no clinical change, nitrogen retention, or alteration in glucose tolerance.

The study of the effect of increased secretion of growth hormone was made in a series of 16 patients with typical acromegaly. The results are shown in Fig. 1*C*, in which a composite curve for 20 control patients is compared with a composite curve for 16 acromegalics. The crossbars represent the standard deviation for each point in time. The phospholipid curves of the acromegalics are lower, and the specific activity curve of the TCA-soluble fraction does not intersect the peak of the phospholipid curve as it does in normals. This was true in each individual case. The *F* test of variance showed that the difference between the groups is highly significant. The total phospholipid-phosphorus values were not abnormal.

The agreement between the results obtained with administered growth hormone and those found in acromegaly suggests that growth hormone decreases the rate of formation of plasma phospholipid. Since the total value does not fall in acromegaly, the destruction of plasma phospholipid must also be slow, indicating a slow phospholipid turnover in this condition. This is the only constant metabolic effect of growth hormone thus far demonstrated in man.

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References

1. W. E. Cornatzer and D. Cayer, *J. Clin. Invest.* 29, 534 (1950).
2. N. R. Diluzio, M. L. Shore, D. B. Zilversmit, *Metabolism Clin. and Exptl.* 3, 424 (1954).

12 December 1955

The person who won't take advice isn't necessarily any more stubborn than the one who is offering it.—Anon.

Book Reviews

Titanium. A. D. McQuillan and M. K. McQuillan. Academic Press, New York; Butterworths, London, 1956. 466 pp. Illus. $10.

The industrial development of titanium metal and alloys made therefrom has suffered in the past from a lack of fundamental information on many aspects of titanium metallurgy. The urgency to produce a satisfactory metal as a basic product, to melt or alloy it into useful combinations, and to fabricate it into useful shapes for a wide variety of applications has led us into measures and procedures that have often handicapped, rather than aided, industrial development in this most recent chapter of industrial technology.

The present volume on *Titanium* by the McQuillans sets out to correct this situation. In the preface to the volume, the authors state that "although the present industrial techniques may be expected to be rapidly superseded, the greater part of the material included in the book will retain its validity." They present, for the first time, a summary of the fundamental facts on which all titanium metallurgy must eventually be based.

The chapters on the production of titanium metal are naturally of special interest, since the future applications of titanium to industries other than those that are government-supported depends on a more economical method of production than the magnesium reduction processes now in common use. The reduction of the halides and subhalides of titanium by sodium, attributed by the authors to Quinn, has interesting possibilities for future production. The reduction of titanium oxide by calcium would be of great importance but this development "awaits the appearance of plentiful supplies of cheap high purity calcium." Electrolytic methods and thermal decomposition of titanium iodide have not yet arrived at the point of large-scale operation.

The engineering features used in the production of end-products in titanium metallurgy are covered in the sections on melting and casting of titanium and its subsequent fabrication into finished parts.

The melting of titanium into ingot form is still one of the bottlenecks of the industry. Consumable and nonconsumable electrodes, double and triple melting—skull melting or melting in graphite—vacuum or argon atmospheres, are problems that are calling for more adequate solutions.

The summaries on the physical properties of titanium and the constitutional diagrams of the known binary titanium alloys provide a brief compendium of information in these fields. The sections on heat treatment and mechanical properties review the extensive literature on these subjects which has been presented in the last 10 years.

As a contribution to the scientific and engineering features of titanium metallurgy, this present volume, I think, is among the best.

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Water. The yearbook of agriculture, 1955. U.S. Department of Agriculture, Washington, D.C., 1955 (order from Supt. of Documents, GPO, Washington 25). xiii + 751 pp. Illus. $2.

This is a very important book. Two presidential commissions and now a proposed national program have dramatized the urgent need for us to face up to the implications of present water problems and a demand that is expected to double by 1975. This volume provides a means by which the technical specialist, the scientist, the farm and civic leader, and the thoughtful citizen can obtain the comprehensive background that is necessary to place their endeavors and their local problems into broad perspective.

In the words of the Yearbook Committee, "our main emphasis is on the facts and basic principles that will help people in reaching the best decisions." This book is centered about the problems of agriculture, but only in the broadest sense. Thus, it reaches far beyond the farm to the factors involved in the making and prediction of weather, runoff, erosion, sedimentation, infiltration, and surface- and ground-water flow. It considers watershed, forest and range management, recreational, wildlife, domestic and irrigation needs, conservation, flood control, legal and legislative implications, and fundamental scientific research. There are 96 topics and a considerably greater number of authors. All things considered, the volume is remarkably well aranged, well integrated, and well written. The reader will find this book valuable, whether he desires to read it as a whole or to select separate papers according to his interests.

The great majority of the authors come from within the Agricultural Research Service, the Forest Service, and the Soil Conservation Service. Where necessary to the continuity and coverage, the editors wisely went beyond this talented group within the U.S. Department of Agriculture and obtained participation from experts from other agencies, such as the U.S. Geological Survey, the Weather Bureau, the Bureau of Reclamation, the U.S. Public Health Service, the Fish and Wildlife Service, and the Saline Water Conversion Program, from university and state experiment stations, from professional associations like the American Waterworks Association, and from private organizations. The quality of the individual efforts is quite uniformly good.

In a book that attempts this coverage, every reader will discover some topic that he feels may have been overlooked or undervalued. I am no exception, and I would have welcomed an article on the possibilities for developing plants with greater drouth resistance and lower water requirements and one on the possibilities for reducing evaporation. In the preface, the editors explain that the agricultural scope of the book precluded much emphasis on hydroelectric power, navigation, pollution, and industrial use. To this I might add engineering structures, large dams, and river diversion projects. Jurisdiction for many of these fields lies within the U.S. Department of the Interior, and it can be hoped that it may someday see fit to publish a companion volume covering these subjects.

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Advances in Geophysics. vol. 2. H. E. Landsberg, Ed. Academic Press, New York, 1955. x + 286 pp. Illus. $7.50.

This volume of extensive review papers, assembled under the competent editorship of Helmut Landsberg, covers diverse and important aspects of geophysics in which there have been substantial developments in the last few years. In addition to being review articles, most of these papers include some new mate-

rial or at least material of which I was not previously aware.

This volume contains five review papers, the first of which, on "Advances in radar weather," is by the McGill University group, which is headed by J. S. Marshall and includes Walter Hitschfeld and K. L. S. Gunn. In this paper, the authors review recent work in a very effective manner and point out that radar analyses are still quite crude and are largely qualitative rather than quantitative, but that partially successful attempts are being made to correlate the radar signal intensity to rainfall intensity. It is possible to distinguish the ice or snow phase from the liquid phase, and thus the observations are helpful in establishing the freezing level. This article, comprising some 50 pages, includes 130 references that would be more valuable if they had been placed in alphabetical sequence rather than in serial sequence.

The second review paper on "Methods of objective weather forecasting" was written by Irving L. Gringorten of the Air Force Cambridge Research Center. The author mentions, as have many other meteorologists, that weather forecasting is still an art and that objective forecasting is not at the moment preeminently successful as compared with older techniques that are based on synoptic observations combined with tables and charts, experience, and a sense of the weather. He notes that "atmospheric motions and conditions are far too . . . complex to be reduced to a simple mathematical model or unified by a system of equations. . . ." Electronic computers aid greatly, but simplifying assumptions must still be made. If the problem can be limited to one or two forecast features, such as winter rainfall in the given locality, a high degree of forecast accuracy may be attained. But if the answer is simply "rain" or "no rain," then other questions, such as visibility and cloud development, remain to be answered subjectively. On the other hand, objective forecasts also involve the quantitative idea, which is not usually involved in subjective forecasts. The author sets up a detailed classification of objective studies and discusses each in turn. His 40 pages of text are followed by a list of 124 references, which, like those in the previous paper, are listed serially rather than alphabetically.

The longest paper in this group is the one by Willard J. Pierson, Jr., of the department of meteorology and oceanography, New York University, and is entitled "Wind generated gravity waves." Pierson has done a splendid job in drawing together the extensive recent work in this field, but at the same time he has gone back and outlined basic theory. He develops a stationary Gaussian process in one dimension and in three dimensions in some detail, discusses the ergodic theorem briefly, and outlines the principles of energy spectra and the propagation and growth of waves. He closes with an outline of practical methods for observing and forecasting ocean waves and a list of unsolved problems. There are 66 items in the references, also in serial order.

The fourth review paper is a 35-page paper entitled "Geological chronometry by radioactive methods," by J. Laurence Kulp of Lamont Geological Observatory, Columbia University. This review covers lead methods, the carbon-14 method, the strontium method, the potassium methods, the helium method, the ionium method, and other potential methods, with the largest section of the paper devoted to the lead methods, including an extensive table of published results and some of the errors involved or possibly involved in the techniques. In the carbon-14 method, he also considers the situation if the cosmic ray flux had been half of its present value during the Ice Age. The other methods are discussed only briefly; however, references to more extensive material are given. The list of 74 references at the end is an important compilation.

The final review paper is on "Earthquake seismographs and associated instruments," by Hugo Benioff of the Seismological Laboratory, California Institute of Technology, himself an important developer of seismographs. Benioff discusses the principles and merits of the various types of seismographs, including torsion seismographs of various subtypes, carrier-current transducer seismographs, linear-strain seismographs, and various appurtenances. He discusses these various types with respect to components measured and the response characteristics. It is a splendid 50-odd page summary of the instrumentation for earthquake measurement. At the end there is a list of 27 references.

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Essentials of Biological and Medical Physics. Ralph W. Stacy, David T. Williams, Ralph E. Worden, Rex O. McMorris. McGraw-Hill, New York–London, 1955. xiv + 586 pp. Illus. $8.50.

This volume undertakes to include generally all the physical aspects of biology and medicine. It is intended to serve as a textbook in biophysics for "senior undergraduates and graduates in the biological sciences and for graduates in physics." Although both fundamental and applied types of material are included, the dominant viewpoint is that "biophysics is a form of applied physics" and includes any field in which physical instruments may be used.

With such a vast domain of unquestionably interesting material, the authors face the necessity of limiting the scope in some fashion. Thus they say: "Since this text is not to be used as an advanced reference, we have not given complete explanation of all phenomena falling within its scope." In fact, more often than not, mathematical formulations in terms of the calculus or differential equations appear without the supporting logic or derivation. This imparts something of a handbook character to the text. References are offered with each chapter where more thorough treatments can be found.

That the major value of biophysics might lie in power of analysis and conceptual contribution to fundamental biology is certainly not the impression one gains from this textbook. There is even a hint that biology is regarded as an inexact science, and hence that rigor cannot be expected.

Granting that conceptual and logical development have not been stressed, one must still be impressed by the colossal task that has been accomplished in bringing so much material together. It would be futile to enumerate the many fields covered. Practically anything that involves physical technology may be found in this volume. No doubt many will find this a valuable source of information and a possible introduction to various fields of research.

This treatment brings into sharp relief a number of serious questions concerning biophysics. What should be included? What should be stressed? How should its students be trained? There is a growing demand for physical technologists to assist in clinical operations and biologists' research. This leads to courses in applied physics, sometimes referred to as health physics.

At the other extreme are those who aspire to mature thinking in fields of biology and biochemistry, which demands disciplined clarity in the study of biophysical mechanism. It matters little what the original training of such a person may have been, since many more years must be devoted to securing both a greater mastery of more advanced mathematical and physical conceptions and a penetrating grasp of biological ideas.

Educators faced with the impossible task of collapsing both a Ph.D. training in physics and one in biology into the usual span of graduate study are making desperate compromises. Some omit mechanics entirely—the very cornerstone of conceptual physics, both classical and modern.

The election that these authors have

made is very interesting: to include a tremendous amount of material, both applied and fundamental, with little explanation of its origin; to include the collegiate level mathematics without showing how it arises; to include the equations and formulas without the orderly development of the ideas that they represent.

In any case this volume brings together the physical aspects of a vast array of biological phenomena. The challenge is unmistakable, and no doubt the student will seek his understanding in his own way.

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The Psychology of Human Differences. Leona E. Tyler. Appleton-Century-Crofts, New York, ed. 2, 1956. 562 pp. Illus. $6.

It was not many years ago that psychologists asked such questions as: "Which is more important, heredity or environment?" "Are whites really brighter than Negroes?" and "Are women is intelligent as men?" Today, however, the questions on these topics are formulated differently. Instead of asking about the relative importance of heredity and environment, we ask how amenable a particular characteristic is to change, and under what circumstances we may expect changes to occur. Differential psychology has matured considerably as a result of continuing experimentation and continuing review of the assumptions, methods, and results of research.

This maturity is reflected in Leona Tyler's meaty and thoughtful volume. In fact, it would be more appropriate to state that this maturity is the reason for, and basis of, her revision of this useful treatise. Nine years have elapsed since the first edition, 9 years in which much significant research in human (individual and group) differences has been completed, 9 years in which earlier work has been placed in better perspective. Tyler has done a masterful job of bringing together, digesting, and integrating the important studies of individual and group differences, drawing on animal studies when they throw light on issues, and pointing up emergent understandings and questions.

It is typical, for example, that in treating the varieties of individual differences she has chapters not only on intelligence, school achievement, vocational aptitudes, personality, and interests and attitudes but also on perception. This last is a field in which much important work has been done since World War II, one that has now developed to a point at which it is clear that perception is indeed basic to any other field. Similarly, the part dealing with group differences covers the traditional topics of sex, race, and nationality, class, age, the deficient, and the gifted but in a strictly up-to-date manner. These two parts are preceded by a part treating the field of differential psychology, and the book closes with a substantial part on factors producing differences. Tyler has written a book that not only treats the traditional topics of differential psychology but does so in a way that makes this field fundamental to any study of social, educational, clinical, or counseling psychology.

Recent contributions receive due emphasis and are related to earlier work. For example, Eysenck's studies of the nature of psychoticism and neuroticism are discussed in some detail, and their contribution to understanding the basic dimensions of personality is incorporated into Tyler's thinking. Jung and Eysenck are juxtaposed in dealing with introversion-extraversion, and authoritarianism and ego-strength get their share of attention, as do the factor analysts.

Behavioral scientists, and others interested in bringing their knowledge and interpretations of the facts on human differences up-to-date, will find this treatise invaluable. Tyler has written in a scholarly but easily understood manner, she has marshaled facts, she has related them to theory, and she has achieved a synthesis which, in my judgment, reflects the best current thinking on this important subject.

DONALD E. SUPER
Department of Psychological Foundations and Services,
Teachers College, Columbia University

New Books

The Chemistry of Phenolic Resins. The formation, structure, and reactions of phenolic resins and related products. Robert W. Martin. Wiley, New York; Chapman & Hall, London, 1956. 298 pp. $9.50.

The Theory of Sound. vols. 1 and 2. John William Strutt, Baron Rayleigh. With a historical introduction by Robert B. Lindsay. Dover, New York, rev. ed. 2, 1945. 480 pp. and 504 pp. Paper, $1.95 each.

Soranus' Gynecology. Translated by Owsei Temkin, assisted by Nicholson J. Eastman, Ludwig Edelstein, Alan F. Guttmacher. Johns Hopkins Press, Baltimore, 1956. 258 pp. $5.

Preface to Empathy. David A. Stewart. Philosophical Library, New York, 1956. 157 pp. $3.75.

Electrochemical Affinity. Studies in electrochemical thermodynamics and kinetics. Pierre Van Rysselberghe. Hermann, Paris, 1955. 109 pp. F. 1250.

Nouveau traité de chimie minérale. vol. I, *Généralités, air, eau, hydrogène, deutèrium, tritium, hélium et gaz inertes.* G. Bouissières, M. Haïssinsky, G. Pannetier, P. Pascal, R. Villard. Masson, Paris, 1956. 1097 pp.

Nineveh and the Old Testament. Studies in Biblical Archaeology No. 3. André Parrot. Translated by B. E. Hooke. Philosophical Library, New York, 1955. 95 pp. $2.75.

Being and Nothingness. An essay on phenomenological ontology. Jean-Paul Sartre. Translated and with an introduction by Hazel E. Barnes. Philosophical Library, New York, 1956. 638 pp. $10.

The Problem of the Picts. F. T. Wainwright, Ed. Philosophical Library, New York, 1956. 187 pp. $6.

Industrial Research Laboratories of the United States. Compiled by James F. Mauk. National Academy of Sciences–National Research Council, Washington, ed. 10, 1956. 560 pp. $10.

World Aircraft Recognition Manual. C. H. Gibbs-Smith and L. E. Bradford. Putnam, London; De Graff, New York, 1956. 269 pp. $3.50.

Therapeutic Use of Artificial Radioisotopes. Paul F. Hahn, Ed. Wiley, New York; Chapman & Hall, London, 1956. 414 pp. $10.

Trace Elements in Human and Animal Nutrition. E. J. Underwood. Academic Press, New York, 1956. 430 pp. $9.50.

The Story of the Royal Dublin Society. Terence de Vere White. Kerryman, Tralee, Ireland, 1955. 228 pp. 21s.

Risk and Gambling. The study of subjective probability. John Cohen and Mark Hansel. Philosophical Library, New York, 1956. 153 pp. $3.50.

Plant Physiology. Meirion Thomas with the collaboration of S. L. Ranson and J. A. Richardson. Philosophical Library, New York, ed. 4, 1956. 692 pp. $12.

Office Work and Automation. Howard S. Levin. Wiley, New York; Chapman & Hall, London, 1956. 203 pp. $4.50.

New Lives for Old. Cultural transformation—Manus, 1928–1953. Margaret Mead. Morrow, New York, 1956. 548 pp. $6.75.

The Men behind the Space Rockets. Heinz Gartmann. Translated by Eustace Wareing and Michael Glenny. McKay, New York, 1956. 185 pp. $3.95.

A Dictionary of Dietetics. Rhoda Ellis. Philosophical Library, New York, 1956. 152 pp. $6.

Demographic Yearbook 1955. 7th issue. Special topic: Population censuses. Statistical Office of the United Nations, New York, 1955. 781 pp. Cloth, $8.50; paper, $7.

Bibliography of Solid Adsorbents, 1943–1953. An annotative bibliographical survey. NBS Circular 566. Victor R. Deitz. National Bureau of Standards, Washington, 1956 (order from Supt. of Documents, GPO, Washington 25). 1528 pp. $8.75.

Analytical Experimental Physics. Michael Ference, Jr., Harvey B. Lemon, Reginald J. Stephenson. University of Chicago Press, Chicago, Ill., rev. ed. 2, 1956. 623 pp. $8.

Radio Electronics. Samuel Seely. McGraw-Hill, New York, 1956. 487 pp. $7.

Scientific Meetings

Recording Animal Sounds

The traditional methods of publication in biology are poorly suited for communicating information about animal sounds, because these sounds cannot be accurately represented by phonetic or musical notations. Communication among workers studying sound production, reception, and reactions of animals is possible, however, through exchange of recordings, but a number of problems arise when this is attempted. These arise from the lack of clear-cut criteria of fidelity for the recordings, the difficulty of locating recordings of interest, and the necessity of preparing copies for equipment with characteristics different from those of the original recording devices.

To discuss means to solve some of these problems and thus to facilitate international exchange of information on animal sounds, a conference was held at Pennsylvania State University, 16–19 Apr. 1956, with Hubert and Mable Frings as cochairmen. Forty biologists from England, France, Germany, and the United States participated. The National Science Foundation of the United States provided financial support.

The first day of the conference was devoted to lectures by R. J. Pumphrey (England), D. R. Griffin (United States), F. P. Möhres (Germany) and R. G. Busnel (France) on the use of recorded animal sounds in biological research. One evening was devoted to informal presentations of recorded sounds of whales, fish, insects, amphibians, and birds by seven of the participants. The rest of the time was occupied with informal discussions.

The participants agreed to form an organization, the International Committee on Biological Acoustics, the objective of which is to foster exchange of information among workers studying acoustic behavior of animals. An executive council, consisting of Busnel, Möhres, Pumphrey, H. W. Frings, D. R. Griffin, W. E. Schevill (U.S.), and T. C. Schneirla (U.S.) was elected, with Busnel, Schneirla, and Frings as the secretariat of the council.

In support of its objectives, the committee plans to set up two organizations: the International Collection of Animal Phonography and the International Library of Biological Acoustics.

The curator of the collection will have three major duties: (i) to receive and catalog samples of recorded animal sounds illustrating published articles, (ii) to publish lists of recordings of animal sounds which investigators agree to make available for study by others, and (iii) to prepare copies of recordings in proper media for exchange between laboratories. P. P. Kellogg (Cornell University) suggested that the Library of Natural Sounds at Cornell University might act as a depository for the short, illustrative recorded samples until the international collection could be set up. The appointment of a curator for the collection and activation of the publishing and copying activities awaits administrative and financial arrangements for the curator's office.

To make the recorded sounds most valuable when they are exchanged, it is necessary that the recipients have exact information about the conditions, both physical and biological, under which the recordings are made. The secretariat of the committee was delegated to prepare a list of informational items to be deposited with recordings. After much discussion of technical problems in recording by the conferees, a tentative list was drawn up.

The library will have two major functions: (i) the preparation and distribution of lists of current literature in the field and (ii) the encouragement of publication of indexed bibliographies on acoustics of special animal groups. To facilitate these activities, all biologists are requested to send two reprints of each of their articles in this field to Mable Frings, secretary to the executive council, at Pennsylvania State University.

The committee is anxious to have broad representation and welcomes inquiries about membership from interested biologists. These should be addressed to the chairman, H. Frings, at Pennsylvania State University, University Park, Pa., U.S.A. There are no dues, the only obligation being to support the activities of the group.

HUBERT and MABLE FRINGS
Pennsylvania State University, University Park, Pennsylvania

Meeting Notes

■ A new organization, the Pavlovian Society for the Experimental Investigation of Behavior, held its first meeting last month at Cornell University. The society has about 35 members, active investigators of animal and human behavior. They emphasize the methodology developed by Ivan Petrovich Pavlov, Russian scientist who was known especially for his studies of conditioned reflexes.

The members plan to meet each year at some member's behavior laboratory to observe and discuss technical methods and results. Their host at Cornell was Howard S. Liddell, director of the university's Behavior Farm.

The society grew out of a meeting a year ago marking the 25th anniversary of the Pavlovian Laboratory of the Henry Phipps Psychiatric Clinic at Johns Hopkins University. W. Horsley Gantt, chairman of the Johns Hopkins laboratory, is chairman of the society's steering committee. Other members are Liddell, who is chairman elect; Edward J. Kempf of Wading River, N.Y.; David McK. Rioch of the Division of Neuropsychiatry at the Walter Reed Army Medical Center in Washington, D.C.; and William G. Reese of the psychiatry department, the University of Arkansas School of Medicine.

■ This year is the centenary of the death of Amedeo Avogadro, the Italian chemist and physicist who discovered one of the fundamental laws concerning the behavior of gases. The Avogadro number, that is, the number of atoms per gram atom of a substance, is one of the most important natural constants.

To mark the occasion the Italian National Accademia dei XL, of which Amedeo Avogadro was a member, organized a commemorative meeting that took place on 6 June in Rome. Appreciations of Avogadro's work were given by the mathematician, Prof. Francesco Severi, president of the Accademia dei XL; Sir Cyril Hinshelwood of Oxford University, president of the Royal Society; Prof. Linus Pauling of the California Institute of Technology; and Prof. G. B. Bonino of the University of Bologna.

■ The seventh Alaskan Science Conference will be held in Juneau, 27–30 Sept. 1956. The meeting is sponsored by the AAAS Alaska Division, the Alaska Section of the American Society of Civil Engineers, and the Alaska Chapter of the Society of American Foresters. Abstracts, which should not exceed 250 words, must be submitted to the appropriate section chairman by *15 July*.

These chairmen are as follows: agriculture, Mr. James J. Hurley, Alaska Rural Rehabilitation Administration, Palmer, Alaska; anthropology, Mrs.

Rosemary Allen Nagel, Alaska Historical Library and Museum, Box 2051, Juneau, Alaska; biology, Mr. Urban "Pete" Nelson, U.S. Fish and Wildlife Service, Juneau, Alaska; engineering, Dr. E. F. Rice, Department of Civil Engineering, University of Alaska, College, Alaska; fisheries, Mr. Walter Kirkness, Senior Biologist, Alaska Department of Fisheries, Juneau, Alaska; forestry, Mr. A. P. Caporaso, Alaskan Forest Research Center, Forest Service, Juneau, Alaska; geology and geography, Mr. Ernest H. Lathram, Alaskan Geology Branch, U.S. Geological Survey, 4 Homewood Place, Menlo Park, California; geophysics, Dr. Masahisa Sugiura and Dr. C. T. Elvey, Geophysical Institute, University of Alaska, College, Alaska; medicine and public health, Dr. Thomas R. A. Davis, Arctic Aeromedical Laboratory, Ladd Air Force Base, Fairbanks, Alaska; social sciences, Mr. Don M. Dafoe, Territorial Commissioner of Education, Alaska Territorial Building, Juneau, Alaska.

■ A Conference on Scientific and Technical Writing will be held 20–24 Aug. in Philadelphia by the University of Pennsylvania's Institute for Cooperative Research. Open to scientists, engineers, editors, writers, and administrators, the conference will provide advanced study and experience-sharing in the art of making technical literature readable. The fundamental problems involved in the communication of technical information will be analyzed, and current systems for handling these problems will be evaluated.

Conference chairman is Harry F. Arader, the university's industrial liaison officer for research and a lecturer in its Moore School of Electrical Engineering. For information and applications, write to Dr. Arader at 3400 Walnut St., Philadelphia 4, Pa.

■ The Committee on Educational Matters of the American Physiological Society will sponsor a second Workshop on the Teaching of Undergraduate Physiology this summer at the University of Wisconsin from 13 to 24 Aug. There will be about 30 participants, including several discussion leaders selected from the Midwest. The informal discussions will concern approaches to subject matter, recent advances, worthwhile experiments (with demonstrations), and general educational problems.

Support from the National Science Foundation will make it possible to reimburse the participants for transportation to and from Madison, and to provide their board and lodging without cost to them while they are on the campus. The director of the 1956 Workshop is Dr. R. R. Ronkin, Department of Biological Sciences, University of Delaware, Newark.

■ The University of Michigan has announced that its seventh annual summer biological symposium, Modern Approaches to Systematic Biology, will take place 9–20 July. Participants include Alfred A. Emerson of the University of Chicago, R. D. Gibbs of McGill University, Hampton L. Carson of Washington University and David D. Keck of the New York Botanical Gardens. The meeting is open to all who wish to attend.

■ The first Pan-American Cancer Cytology Congress will be held in Miami, Fla., 25–29 Apr. 1957. Those who wish to deliver a paper should submit the title and a 100-word summary to the secretary, Dr. George Gey, Department of Surgery, Johns Hopkins Hospital, 601 N. Broadway, Baltimore 5, Md. Preference will be given to early applicants.

Two $1000 Wien awards, one for 1956 and one for 1957, will be presented at the conclusion of the congress to the two scientists whose papers represent outstanding research in cancer cytology. The Wien award was established in 1953 by Leonard Wien, former president of the Cancer Institute at Miami, Fla. The award committee is headed by E. V. Cowdry. For information about the congress, write to Mrs. Elizabeth Maselli, Box 633, Miami 34, Fla.

■ The 11th annual Calorimetry Conference will be held at Johns Hopkins University, 14–15 Sept. The program will cover theoretical aspects of thermal transitions and the description of recent calorimetric measurements and apparatus used over a range of temperatures from below 1°K to about 750°K. Papers will be presented on automatic and high-precision calorimetry, microcalorimetry, thermometry, and so forth.

The chairman for the meeting will be Edgar F. Westrum, Jr., of the University of Michigan; the program chairman is Henry A. Boorse of the Pupin Physics Laboratories, Columbia University. Correspondence about the conference should be addressed to the latter.

■ The 26th annual meeting of the Biological Photographers Association, Inc., will be held in Rochester, N.Y., 27–31 Aug. This is the first 5-day meeting in the group's history. One of the features of the meeting will be an exhibit of books written or illustrated by members.

Society Elections

■ Minnesota Academy of Science: pres., Edward J. Baldes, Mayo Clinic; v. pres., Harold T. Peters, State Teachers College; sec.-treas., Blanchard O. Krogstad, University of Minnesota, Duluth. The representative to the AAAS Council is Shirley P. Miller.

■ American Board of Clinical Chemistry: pres., Marschelle H. Power, Mayo Clinic; v. pres., Warren M. Sperry, New York State Psychiatric Institute; sec.-treas., William A. Wolff, Bowman Gray School of Medicine.

■ Alabama Academy of Science: pres., J. Allen Tower, Birmingham-Southern College; pres.-elect, Howard Carr, Alabama Polytechnic Institute; sec., Herbert A. McCullough, Howard College, Birmingham; treas., Locke White, Southern Research Institute. The representative to the AAAS Council is Patrick H. Yancey.

Forthcoming Events

July

16–17. Symposium on Synthetic Polymer Chemistry, Notre Dame, Ind. (G. F. D'Alelio, Dept. of Chemistry, Univ. of Notre Dame, Notre Dame.)

16–21. French Assoc. for the Advancement of Science, Dijon, France. (Mlle. Henri-Martin, Secretary, 28, rue Serpente, Paris 6e.)

16–21. International Organization for Standardization, Geneva, Switzerland. (IOS, 39, route de Malagnou, Geneva.)

17–26. International Soc. of Photogrammetry, 8th cong., Stockholm, Sweden. (P. O. Fagerholm, Bragevägen 8, Stockholm.)

18–20. Soc. for the Study of Development and Growth, annual, Providence, R.I. (M. V. Edds, Jr., Brown Univ., Providence 12.)

22–27. International Cong. of Pediatrics, 8th, Copenhagen, Denmark. (Prof. Franconi, Kinderspital, Steinwiesstrasse 75, Zürich 32, Switzerland.)

22–28. International Cong. on Housing and Town Planning, Vienna, Austria. (H. van der Weijde, International Federation for Housing and Town Planning, Paleisstraat 5, The Hague, Netherlands.)

22–28. International Cong. of Radiology, 8th, Mexico, D.F., Mexico. (J. Noriega, Tepic 126, 2° piso, Mexico, D.F.)

23–26. International Cong. of Developmental Biology, 1st, Providence, R.I. (J. W. Wilson, Dept. of Biology, Brown Univ., Providence.)

25–27. Conf. on Solar-Weather Relationships sponsored by American Meteorological Soc., Boulder, Colo. (K. C. Spengler, 3 Joy St., Boston 8, Mass.)

26–28. International Conf. on Biochemical Problems of Lipids, 3rd, Brussels, Belgium. (R. Ruyssen, St. Jansvest 12, Univ. of Ghent, Ghent, Belgium.)

27–31. Symposium on Cytodifferentiation (invitational), Providence, R.I. (J. W. Wilson, Dept. of Biology, Brown Univ., Providence.)

27–7. International Limnology Cong., 13th, Helsinki, Finland. (H. Luther, Snellmansgatan 16 C 36, Helsinki.)

30–31. Oak Ridge Regional Symposium, 9th, Blacksburg, Va. (Information Dept., Oak Ridge Inst. of Nuclear Studies, P.O. Box 117, Oak Ridge, Tenn.)

30–4. International Physiological Cong., 20th, Brussels, Belgium. (J. J. Reuse, Faculté de Medecine, 115 Boulevard de Waterloo, Brussels.)

August

1–6. International Cong. of Human Genetics, 1st, Copenhagen, Denmark. (Secretariate, 1st ICHG, 14, Tagensvej, Copenhagen, N.)

5–10. International Conf. of Social Work, 8th, Munich, Germany. (J. R. Hoffer, 345 E. 46 St., New York 17.)

6–10. Poultry Science Assoc., annual, Raleigh, N.C. (C. B. Ryan, Dept. of Poultry Husbandry, Texas A & M College, College Station.)

6–1. International Mathematical Symposium on Algebraic Topology and Its Applications, Mexico City, Mexico. (Miss J. Silva, Instituto de Matemáticas, Torre de Ciencias, Ciudad Universitaria, México 20, D.F.)

9–18. International Geographical Cong., 18th, Rio de Janeiro, Brazil. (H. O'R. Sternberg, Centro de Pesquisas de Geografia do Brasil, Faculdade Nacional de Filosofia, Av. Presidente Antonio Carlos 40, Rio de Janeiro.)

10–11. Minnesota Acad. of Science, New London, Minn. (B. O. Krogstad, Univ. of Minnesota, Duluth 5B.)

12–17. World Federation for Mental Health, 9th annual, Berlin, Germany. (Secretariat, 19 Manchester St., London W.1, England.)

15–22. Canadian Teachers' Federation, Fredericton, N.B., Canada. (G. G. Croskery, 444 MacLaren St., Ottawa, Ontario, Canada.)

16–21. Symposium on X-Ray Microscopy and Microradiography, Cambridge, England. (W. C. Nixon, Cavendish Lab., Cambridge.)

17–25. International Cong. of Entomology, 10th, Montreal, Canada. (J. A. Downes, Div. of Entomology, Science Service Bldg., Ottawa, Ont., Canada.)

19–23. International Cong. on Diseases of the Chest, 4th, Cologne, Germany. (Executive Offices, American College of Chest Physicians, 112 E. Chestnut St., Chicago 11, Ill.)

19–24. International Symposium on Combustion, 6th, New Haven, Conn. (Combustion Symposium Office, Mason Lab., Yale Univ., New Haven 11.)

20–21. Mathematical Assoc. of America, 37th summer, Seattle, Wash. (H. M. Gehman, Univ. of Buffalo, Buffalo 14, N.Y.)

20–21. National Telemetering Conf., Los Angeles, Calif. (R. E. Rawlins, Lockheed Aircraft Corp., Burbank, Calif.)

20–24. Conf. on Scientific and Technical Writing, Philadelphia, Pa. (H. F. Arader, Univ. of Pennsylvania, 3400 Walnut St., Philadelphia 4.)

20–24. Institute of Mathematical Statistics, Seattle, Wash. (G. E. Nicholson, Jr., Dept. of Statistics, Univ. of North Carolina, Chapel Hill.)

20–24. International Cong. of Physical Medicine, 2nd, Copenhagen, Denmark. (S. Clemmesen, Kommune-hospitalet, Copenhagen.)

20–25. American Mathematical Soc., 61st summer, Seattle, Wash. (J. H. Curtiss, AMS, 80 Waterman St., Providence 6, R.I.)

22–29. World Cong. of Sociology, 3rd, Amsterdam, Netherlands. (T. B. Bottomore, Skepper House, 13 Endsleigh St., London, W.C.1, England.)

26–30. American Inst. of Biological Sciences, Storrs, Conn. (H. T. Cox, 2000 P St., NW, Washington 6.)

The following 23 meetings are being held in conjunction with the AIBS meeting at Storrs, Conn.

26–30. American Bryological Soc. (L. J. Gier, Dept. of Biology, William Jewell College, Liberty, Mo.)

26–30. American Fern Soc., annual. (Mildred E. Faust, 501 University Pl., Syracuse 10, N.Y.)

26–30. American Microscopical Soc. (R. W. Pennak, Dept. of Biology, Univ. of Colorado, Boulder.)

26–30. American Soc. for Horticultural Science, annual. (F. S. Howlett, Ohio Agricultural Experimental Station, Wooster, Ohio.)

26–30. American Soc. of Human Genetics. (E. J. Gardner, Dept. of Zoology, Utah State Agricultural College, Logan.)

26–30. American Soc. of Limnology and Oceanography, annual. (B. H. Ketchum, Woods Hole Oceanographic Institution, Woods Hole, Mass.)

26–30. American Soc. of Parasitologists, annual. (A. C. Walton, Knox College, Galesburg, Ill.)

26–30. American Soc. of Plant Physiologists, annual. (A. W. Galston, Dept. of Botany, Yale Univ., New Haven, Conn.)

26–30. American Soc. of Plant Taxonomists, annual. (R. C. Rollins, Gray Herbarium, Harvard Univ., 22 Divinity Ave., Cambridge 38, Mass.)

26–30. Biometric Soc., ENAR. (A. M. Dutton, Univ. of Rochester, Box 287, Station 3, Rochester 20, N.Y.)

26–30. Botanical Soc. of America, annual. (H. C. Bold, Vanderbilt Univ., Nashville, Tenn.)

26–30. Ecological Soc. of America, annual. (J. F. Reed, Dept. of Botany, Univ. of Wyoming, Laramie.)

26–30. Mycological Soc. of America, annual. (C. J. Alexopoulos, Dept. of Botany, Michigan State Univ., East Lansing.)

26–30. National Assoc. of Biology Teachers. (P. V. Webster, Bryan City Schools, Bryan, Ohio.)

26–30. Nature Conservancy. (G. B. Fell, 4200 22 St., NE, Washington 18.)

26–30. Phycological Soc. of America, annual. (P. C. Silva, Dept. of Botany, Univ. of Illinois, Urbana.)

26–30. Soc. of General Physiologists. (A. M. Shanes, National Inst. of Arthritis and Metabolic Diseases, Bethesda 14, Md.)

26–30. Soc. for Industrial Microbiology, annual. (C. P. Porter, Dept. of Biological Sciences, Purdue Univ., West Lafayette, Ind.)

26–30. Soc. of Protozoologists, annual. (N. D. Levine, College of Veterinary Medicine, Univ. of Illinois, Urbana.)

26–30. Soc. of Systematic Zoology. (R. E. Blackwelder, 3728 Second St. South, Arlington 4, Va.)

27–29. American Soc. of Zoologists, 53rd annual. (R. T. Kempton, Marineland Research Laboratory, Marineland, Fla.)

27–29. Genetics Soc. of America, an-

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nual. (H. B. Newcombe, Atomic Energy of Canada, Ltd., Chalk River, Ont.)

27–31. American Soc. of Naturalists, annual. (B. Wallace, Biological Lab., Cold Spring Harbor, Long Island, N.Y.)

26–1. International Soc. of Haematology, 6th cong., Boston, Mass. (ISH, New England Medical Center, Harrison Ave. at Bennet St., Boston 11.)

27–31. Biological Photographic Assoc., 26th annual, Rochester, N.Y. (BPA, c/o 343 State St., Rochester 4.)

27–31. Colloquium on Statistical Mechanics of Transport Processes, IUPAP, Brussels, Belgium. (I. Prigogine, 40 Avenue F. D. Roosevelt, Brussels.)

27–31. Infrared Spectroscopy Inst., 7th annual, Nashville, Tenn. (N. Fuson, Dept. of Physics, Fisk Univ., Nashville 8.)

28–2. Colloquium on Semiconductors and Phosphors, IUPAP, Garmisch-Partenkirchen, Germany. (H. Maier-Leibnitz, Walter-von-Dyck-Platz 1, Munich 2, Germany.)

29–5. British Assoc. for the Advancement of Science, annual, Sheffield, England. (Secretary, BAAS, Burlington House, Piccadilly, London, W.1., England.)

29–8. International Soc. of Soil Science, 6th cong., Paris. (F. A. Van Baren, ISSS, Royal Tropical Inst., Mauritskade 63, Amsterdam, Netherlands.)

30–5. American Psychological Assoc., Chicago, Ill. (F. H. Sanford, 1333 16 St., NW, Washington 6.)

30–5. Psychometric Soc., Chicago, Ill. (L. V. Jones, Dept. of Psychology, Univ. of Chicago, Chicago 37.)

September

1–9. International Cong. of Anthropological and Ethnological Sciences, 5th, Philadelphia, Pa. (Secretary, American Organizing Committee, International Cong. of Anthropology, National Acad. of Sciences–National Research Council, 2101 Constitution Ave., Washington 25.)

2–7. Laurentian Hormone Conf., AAAS, Mont Tremblant, Quebec, Canada. (Committee on Arrangements, LHC, 222 Maple Ave., Shrewsbury, Mass.)

4–6. International Assoc. of Milk and Food Sanitarians, annual, Seattle, Wash. (H. L. Thomasson, IAMFS, Box 437, Shelbyville, Ind.)

4–11. International Geological Cong., 20th, Mexico, D.F. (Congreso Geológico Internacional, Calle Balderas 36, Despacho 302-A, Mexico, D.F.)

4–11. International Paleontological Union, Mexico, D.F. (H. E. Vokes, Johns Hopkins Univ., Baltimore 18, Md.)

5–7. Wyoming Geological Field Conf., 11th annual, Moran, Wyo. (K. W. Frielinghausen, Box 1571, Casper, Wyo.)

5–13. International Cong. of Applied Mechanics, 9th, Brussels, Belgium. (H. L. Dryden, Director, National Advisory Committee for Aeronautics, Washington 25.)

6–8. American Political Science Assoc., annual, Washington, D.C. (E. M. Kirkpatrick, APSA, 1726 Massachusetts Ave., NW, Washington 6.)

6–8. Phi Sigma Soc., Ann Arbor, Mich. (K. F. Lagler, Dept. of Fisheries, School of Natural Resources, Univ. of Michigan, Ann Arbor.)

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(2) Henley and Pollard, J. Lab. & Clin. Med. *46*, 785, (1955)
(Lactic Dehydrogenase method)

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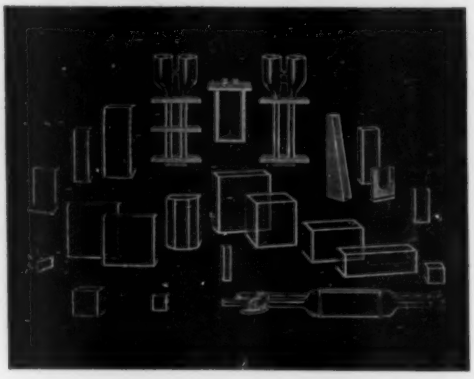

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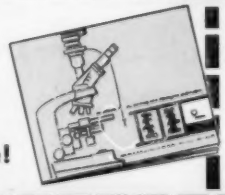

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